THE WORKPLACE ENVIRONMENT SERIES: CAN SMOKING BE ACCOMMODATED?

Executive Summaries

- SCIENTIFIC QUESTIONS AND ANSWERS
- A HUMAN RESOURCES PERSPECTIVE
- TECHNOLOGY AND INDOOR AIR QUALITY
- LEGAL CONSIDERATIONS

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CAN SMOKING BE ACCOMMODATED?

In *The Workplace Environment* series, you can examine that question in light of the scientific, human resources, technical and legal aspects of the issue as well as the practical and technical options available to accommodate smoking in the workplace.

To help you determine the most appropriate recipients of the more detailed material, or to clarify your own consideration of key aspects of workplace smoking, this brochure contains executive summaries of the following:

- *Scientific Questions and Answers*
- *A Human Resources Perspective*
- *Technology and Indoor Air Quality*
- *Legal Considerations*

(A sample guideline to accommodating smoking is also included.)

For further information on any or all of the topics addressed in this brochure, please call toll-free 1-800-222-5995.

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SCIENTIFIC QUESTIONS AND ANSWERS

ENVIRONMENTAL TOBACCO SMOKE: WHAT IS IT?

Environmental tobacco smoke (ETS) is a highly dilute mixture from two sources: the "mainstream" smoke exhaled by a smoker and the "sidestream" smoke from the burning end of a cigarette. It differs chemically and physically from both of its original sources. ETS is a dynamic, ever-changing mixture which, as it ages and dissipates, undergoes chemical and physical changes. ETS is not equivalent to either of its sources.

MOST STUDIES ABOUT EXPOSURE ARE BASED ON MEMORIES — NOT MEASUREMENTS

These studies — called epidemiologic studies — have relied on an individual's ability to recall exposure to tobacco smoke and assess the level of that exposure in response to questions asked years, even decades, after the event occurred.

ACTUAL MEASUREMENTS SHOW WORKPLACE EXPOSURE LEVELS ARE MINIMAL

Because it's visible and has a characteristic aroma, tobacco smoke exposure levels are mistakenly perceived to be greater than actual measurements indicate. Visible tobacco smoke is a marker for what usually lies at the heart of indoor air quality problems — inadequate ventilation.

WORKPLACE EXPOSURE TO TOBACCO SMOKE IS MANAGEABLE

There are many ways to minimize exposure to ETS, including relocating workstations, supplementing filtration, increasing ventilation, designating smoking areas or providing separate smoking rooms. Applying technical options can improve air quality while accommodating the preferences of smokers and non-smokers alike.

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A HUMAN RESOURCES PERSPECTIVE

SMOKING IS ONE ASPECT OF THE TOTAL INDOOR ENVIRONMENT

Balancing the shifting requirements of employees and management requires the special skills of human resources managers working closely with other departments to develop a workable smoking policy.

THE WORKPLACE: BLENDING HUMAN AND TECHNICAL FACTORS

With one-third of our time spent at work, a productive workplace recognizes individuals' varying requirements for a reasonable degree of flexibility and control over technical factors while accommodating personal preferences.

INDOOR AIR QUALITY IS MORE THAN MEETS THE EYE

While smoking is often perceived as the cause of poor indoor air quality, visible accumulation of tobacco smoke is usually evidence of a more pervasive problem — inadequate ventilation.

HUMANS AND HIGH TECH TERRAIN FORM A WORKING PARTNERSHIP

In the 1980s, the expansion of the white collar workforce led to extensive use of ergonomic designs in furniture, equipment and office planning. Whether it is the ability to adjust their chairs for pitch and height, or to block out unwanted sounds, or to select from more than one possible light source, giving employees a choice has come to play a larger role in managing today's complex workplace effectively.

DEVELOPING A WORKABLE SMOKING POLICY IS A PROCESS OF INCLUSION

A reasonable policy recognizes and respects the diversity of all employees while being compatible with accepted customs, individual preferences, work requirements, local culture and applicable laws.

SO WHAT ARE THE VARIOUS POLICY OPTIONS?

Each workplace can develop a policy which suits it best — unrestricted, restricted, designated rooms or even a ban. The latter, of course, does not reflect a spirit of inclusion and mutual respect.

ACCOMMODATING SMOKING IS A PRACTICAL GOAL THAT CAN BE ACHIEVED

Smoking accommodation is an achievable goal that integrates people, policy and practical technology.

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A GUIDELINE TO ACCOMMODATING SMOKING

Statement of Purpose

[Company Name] respects equally the rights of non-smokers and smokers within our workplaces. We encourage employees to show courtesy and mutual respect in accommodating their colleagues' wishes to smoke or not to smoke. We endeavor to create and sustain acceptable indoor air quality in our workplaces whether or not smoking occurs. It is our intention to minimize annoyance and to foster a cooperative and productive work environment.

Smoking Restrictions

- All Facilities

  Each facility should identify those areas in which smoking is prohibited by applicable law, ordinance, regulation or code.

- Factories and Production Facilities

  Smoking is prohibited in all areas where it is a fire hazard or interferes with the manufacturing process.

Smoking Accommodation

- Private Offices

  Employees may smoke in their own offices, but should seek the occupant's permission before smoking in another employee's office.

- Common Work Areas

  If an employee is annoyed by tobacco smoke in the air, he or she should first speak to the smoker and seek an accommodation through discussion. If the employees cannot reach a mutually satisfactory arrangement, they should discuss the issue with their supervisor. The supervisor or manager is responsible for considering the preferences of each employee. The responsible human resources staff should be consulted to ensure consistent accommodation decisions and that appropriate steps are taken regarding the indoor work environment.

- Conference Rooms and Training Rooms

  Participants in conference room or training room meetings should show courtesy to each other while smoking during meetings. If a participant is bothered by another's smoke, he or she should seek seating to minimize the annoyance. If a meeting is non-smoking, smoking breaks should be provided.

- Cafeteria

  Smoking is permitted in all dining areas except in the section designated as a non-smoking area. Employees will refrain from smoking while in a designated non-smoking area.

- Company Vehicles and Aircraft

  Smoking is permitted in company vehicles and in company aircraft except when restricted by regulation. We expect smoking and non-smoking colleagues to be especially mindful of each other's preferences when travelling together in these confined spaces.

- Smoking Areas and/or Lounge

  In factories, production facilities and other areas where smoking is prohibited, well-ventilated and convenient areas should be provided for smoking during employee breaks.

A Final Note

Smoking, like other activities pursued in a social context, may bother some people. [Company Name] believes that courtesy and mutual respect of other's preferences can resolve differences over smoking. We expect each of our employees to exhibit a spirit of reasonable accommodation in dealing with this matter.

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TECHNOLOGY AND INDOOR AIR QUALITY

ENGINEERING AND TECHNOLOGY PROVIDE GOOD NEWS FOR EMPLOYERS

Improved indoor air quality (IAQ) is an achievable goal through a variety of basic engineering principles and technologies, usually at low cost.

WHAT HAPPENED TO THE INDOOR ENVIRONMENT?

Energy-saving building techniques of the '70s and '80s, lower ventilation rates, and the use of more synthetic materials in the modern office have set the stage for poorer air quality.

A BUILDING SYSTEMS APPROACH IS EFFECTIVE AND PRACTICAL

Engineering and advanced technology with an emphasis on proper ventilation can provide improved IAQ for all buildings, whether or not smoking occurs.

DEFICIENT BUILDINGS AND SMOKING: WHAT'S AN OWNER TO DO?

Enhancement of the internal environment is a cost-beneficial investment which can result in higher productivity. Possible solutions range from restoring air handling systems to their original potential — to extending their capabilities with advanced technologies. By first addressing indoor air quality, decisions about accommodating smoking can then reflect carefully thought out policy discussions — rather than a hasty, but inappropriate, response to air quality complaints.

ACCOMMODATING SMOKING: WHAT'S A TENANT TO DO?

Dialogue with the building management is essential to ensure that cost-cutting measures aren't reducing air quality in a tenant's space and that tenant-proposed smoking accommodation can be achieved. Usually building management is pleased to work with tenants to their mutual benefit.

TECHNOLOGY CAN COMPLEMENT ANY POLICY

Buildings vary dramatically in size, design, building materials, age, geographic location and the preferences of their occupants. Numerous technical options exist to complement any smoking policy — in any workplace environment.

TECHNICAL OPTIONS PROVIDE REASONABLE ACCOMMODATION FOR ALL

Occupants in buildings with adequate ventilation generally have few complaints about air quality or smoking. Most companies would prefer to accommodate smokers while being responsive to the wishes of non-smokers. Engineering and technology provide the options to do both: improve air quality *and* accommodate smoking.

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LEGAL CONSIDERATIONS

SMOKING IN THE WORKPLACE: THE CHOICE REMAINS

The Environmental Protection Agency's (EPA) report on environmental tobacco smoke (ETS) should not interfere with the employer's or building owner's efforts to accommodate smoking, even though the report's release and subsequent publicity have raised concerns.

EPA REPORT: SCIENCE OR POLITICS?

An expert panel of scientists convened by the EPA itself raised serious concerns about the EPA's "adjusting science to fit policy." The agency's report on ETS is an example of how justified that concern is.

EPA HAS NO STATUTORY AUTHORITY IN THE WORKPLACE

It is the Occupational Safety and Health Administration (OSHA), not the EPA, that has authority for the workplace and is currently studying the issue of air quality. OSHA has rejected previous requests to mandate smoking bans.

COURTS HAVE NOT BEEN SUPPORTIVE OF ETS CLAIMS

Legally binding decisions on workplace-related ETS claims under any legal theory have historically provided little support for workplace smoking bans. In all such claims, the claimant must prove that the injury was caused by exposure to ETS (not something else) and that the exposure was in the workplace (not in other places).

SMOKING BANS WILL NOT ELIMINATE INDOOR AIR QUALITY PROBLEMS

Visible accumulation of tobacco smoke is usually evidence of a more pervasive problem in today's modern buildings — inadequate ventilation. While a smoking ban will remove this visible marker from the air, it will not remove other constituents of indoor air, a build up of which can create a "sick" building and potential indoor air quality litigation.

ACCOMMODATING SMOKING IS AN EMPLOYER'S CHOICE

While some employees may find smoking objectionable, many employees do wish to smoke. Unless otherwise regulated, employers can choose to accommodate smoking.

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The Workplace Environment

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SCIENTIFIC QUESTIONS AND ANSWERS – EXECUTIVE SUMMARY

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SMOKING IN THE WORKPLACE: SCIENTIFIC QUESTIONS & ANSWERS

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While the science of tobacco smoke exposure in the workplace can be complex, concerned individuals tend to ask straightforward questions about what it is and how it can be managed. Following are some of the most frequently asked questions. Citations to the scientific literature are provided so that you can review the science for yourself should you so choose. Non-smoker exposure in the workplace can be effectively minimized and smoking accommodated.

ENVIRONMENTAL TOBACCO SMOKE: WHAT IS IT?

What is tobacco smoke in the air, often referred to as Environmental Tobacco Smoke?

Environmental tobacco smoke (ETS) is a highly diluted mixture from two different sources: sidestream smoke (the smoke from the burning end of a cigarette) and exhaled mainstream smoke (that smoke which the smoker exhales). This mixture changes in chemical composition as it ages and becomes diluted.[1-5] It is both physically and quantitatively different from either of its original sources. The reported levels of individual components in this mixture (constituents) are *diluted hundreds to even thousands of times* compared to levels reported for either mainstream or sidestream smoke.

MOST STUDIES ABOUT EXPOSURE ARE BASED ON MEMORIES — NOT MEASUREMENTS

On what exposure data have the studies about environmental tobacco smoke been based?

Published population (sometimes referred to as "epidemio-logic") studies that report associations between tobacco smoke exposures and chronic disease in non-smokers are not, in fact, based on actual exposure assessments of tobacco smoke.

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Such epidemiologic studies have relied on an individual's ability to recall exposure to tobacco smoke and assess the level of that exposure in response to questions asked years, even decades, after the event occurred.

Questionnaire responses regarding one's past exposure to tobacco smoke in the home, workplace, etc., are used in place of actual measurements for tobacco smoke exposure. Some studies indicate, however, that such subjective assessments are extremely unreliable, resulting in inaccurate measures of exposure.[7-8]

Are there differences between the questionnaire responses of remembered exposures and actual measurements?

A primary deficiency in the population studies on ETS is the lack of reliable exposure data. Questionnaire responses about exposure often vary widely when compared with actual measurements of tobacco smoke constituents in the indoor air.[9]

The literature reporting actual measurements of ETS in the workplace as well as those from published population studies does not provide convincing support for the claim that such exposure in the workplace is associated with an increased risk of chronic disease among non-smokers.

How accurately would you recall what you have been exposed to since childhood?!

What about the health claims reported in those studies, particularly in the workplace?

We are concerned about any claim related to our products. We carefully analyze developments within the scientific community that claim a possible relationship between tobacco smoke exposure and the risk of disease in non-smokers. Since the early 1980's a number of studies in scientific literature have examined that possible relationship. Among the diseases and conditions examined in the literature are lung cancer, heart disease, respiratory disease and conditions other than cancer, the aggravation of pre-existing disease and allergy, irritation and annoyance.

Taken as a whole, the studies provide inadequate support for the claim that tobacco smoke exposures in the workplace are related to an increased risk of lung cancer among non-smokers.

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The assertion that ETS exposure may increase the risk of lung cancer in non-smokers is based upon an interpretation of data from population studies involving non-smoking women married to smokers. A substantial number of those studies also assess reported workplace exposure to tobacco smoke by way of questionnaire response. *An overwhelming majority of those studies report no overall significant association between tobacco smoke exposure at work and increased risks of lung cancer among non-smokers.*[10-23]

Similarly, roughly half of the published studies on spousal smoking and heart disease attempt to address workplace exposure to tobacco smoke among non-smokers.[24-28] *None of those studies report a statistically increased risk of heart disease among non-smokers who claim exposure to tobacco smoke in the workplace.*

Few studies have examined the issue of exposure to tobacco smoke in the workplace and respiratory disease other than cancer in non-smoking adults. *The studies that have been conducted on this issue have reported mixed results.*[29-34] Indeed, studies on possible asthmatic reactions to tobacco smoke have been inconsistent in their findings.[35-44] Some studies report an increase in subjective symptoms among asthmatics who are voluntarily exposed to tobacco smoke in a clinical setting, and others report that exposures do not elicit objective responses in asthmatics.

ACTUAL MEASUREMENTS SHOW WORKPLACE EXPOSURE LEVELS ARE MINIMAL

What is the typical level of non-smoker exposure to tobacco smoke in the workplace?

A number of published studies in the scientific literature indicate that non-smoker exposure to tobacco smoke in typical office environments - although often perceived as great - is minimal.

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For example, researchers report that there is little difference in the amount of carbon monoxide in the air mixture in smoking and non-smoking areas of workplaces and public places, or in homes with and without smokers.[45-50] Even nicotine, often used as a marker because it is unique to tobacco smoke, has been reported as minimal. Typical measurements of nicotine range from an exposure equivalent of 1/100th to less than 1/1000th of one filter cigarette per hour.[51-58] This means that a non-smoker would have to spend from 100 to over 1000 hours continuously in an office, restaurant or public place in order to be exposed to the nicotine equivalent of a single smoked cigarette.

What is the role of ETS in overall indoor air quality (IAQ) problems?

Though often the initial cause of complaints about poor indoor air quality, *investigations of over 2,000 buildings, some of which were "sick" or problem buildings, indicate that tobacco smoke is a major factor in only two to four percent of the buildings investigated for complaints about IAQ.*[59-65]

Much attention in both the popular press and scientific literature has been given to quality of indoor air, especially in the workplace. A specific kind of building problem associated with poor indoor air quality in workplaces is called the "sick-building syndrome." Sick-building syndrome has been defined by the World Health Organization (1982) as an array of health-related symptoms including headache, eye, nose and throat irritation, dry/itchy skin, dizziness, chest tightness, fatigue and difficulty in concentrating.[66] Because it is often the only visible constituent in indoor air, and it is easily identified by its aroma, tobacco smoke is often blamed for problems in sick buildings even though the same complaints arise in buildings where no smoking occurs.

What is the major cause of IAQ problems?

Ventilation problems have been associated with air quality complaints in over half of the buildings investigated.

These problems have been traced to inadequate fresh air ventilation and distribution, insufficient air filtration, and poor

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maintenance. If the ventilation system cannot satisfactorily handle even a moderate amount of smoking, then it is unlikely to adequately handle the buildup of other constituents in the same environment. If smoking is conducted in an enclosed, unvented area, then byproducts of combustion will accumulate.

However, byproducts of humans and their activities, as well as any emissions from furnishings, fixtures, fitting and office processes also will accumulate at the same time. Undoubtedly, this accumulation of airborne substances may be considered unpleasant and irritating to others sharing the same space. Fortunately, engineering principles and technologies exist which can provide acceptable air quality and accommodate smoking.

Would a smoking ban solve IAQ problems?

A ban will neither improve fresh air ventilation nor ensure acceptable indoor air quality.

There are those who advocate a smoking ban as a quick, inexpensive "solution" to complaints about IAQ. After reviewing the databases on sick-building syndrome, one investigator concluded: "Removing the smoker entirely, then, may not affect health and comfort problems in 95% to 98% of sick buildings."[67] In addition, a ban may create disharmony between smoking and non-smoking employees.[68]

WORKPLACE EXPOSURE TO TOBACCO SMOKE IS MANAGEABLE

Are there effective ways of minimizing non-smoker exposure in the workplace?

The scientific literature reveals that separation of smokers and non-smokers can effectively minimize non-smoker exposure to tobacco smoke — even without creating separate rooms and exhaust ventilation systems.[48, 53, 69-74]

Since workplaces are infinitely varied, situations may arise where complaints about exposure to tobacco smoke must be

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addressed by the employer. One study reported that the use of designated smoking areas reduced exposure to tobacco smoke by 95%.[69] Another study of a smoking-restricted office building reported that the amount of nicotine in the air measurable in non-smoking areas was virtually undetectable, suggesting that tobacco smoke had a negligible impact on the non-smoking areas of the building.[70]

Similarly, Canadian researchers, in a series of reports, presented results on the measurement of levels of tobacco smoke constituents in offices where smoking was allowed, but with varying degrees of restrictions, and where smoking was allowed without any restrictions. They reported no significant differences in average tobacco smoke constituent levels between non-smoking offices that received recirculated air from smoking areas and non-smoking offices that did not receive recirculated air.[71-74] They concluded: the provision of a designated smoking area appears to effectively reduce ETS constituent levels in non-smoking offices. even if the designated smoking area is not separately ventilated.[74]

Are there easy ways to deal with the annoyance factor of tobacco smoke?

One study suggests that *"an inexpensive strategy of reducing complaints associated with tobacco smoke"* is to *"eliminate visual contact between smokers and non-smokers."*

The authors addressed the issue of non-smokers' perception of annoyance and irritation from tobacco smoke exposures. A study involving over 250 subjects revealed that visual contact with a smoker affects the magnitude of reported response to tobacco smoke among selected non-smokers. This remedy is easily obtained through the simple separation of smokers and non-smokers.[75]

Other approaches to minimize tobacco smoke exposures and to decrease annoyance include the following; relocating work stations, supplementing filtration, increasing outdoor air ventilation to commonly accepted ventilation standards and levels specified in building codes; or the use of desktop air

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cleaners or smokeless ashtrays for smokers. Such measures reportedly have been effective in addressing complaints and would require few additional costs for the employer. In addition, these remedies are based on the concept of accommodation for both smokers and non-smokers, and the belief that cooperation, courtesy and respect between the two groups may effectively be fostered in the workplace.

Can smoking be accommodated in the workplace?

According to the data, non-smoker exposure can be effectively minimized and smoking accommodated. Nonetheless, we recognize the complexity of the tobacco smoke issue and realize that regardless of the actual measured levels reported, some individuals are concerned about tobacco smoke exposure in the workplace. To respond to those concerns, employers have an array of technical options available (described in a companion piece entitled *Technology and Indoor Air Quality*) which can accommodate both the employee who wishes to smoke and those who want to minimize their exposure.

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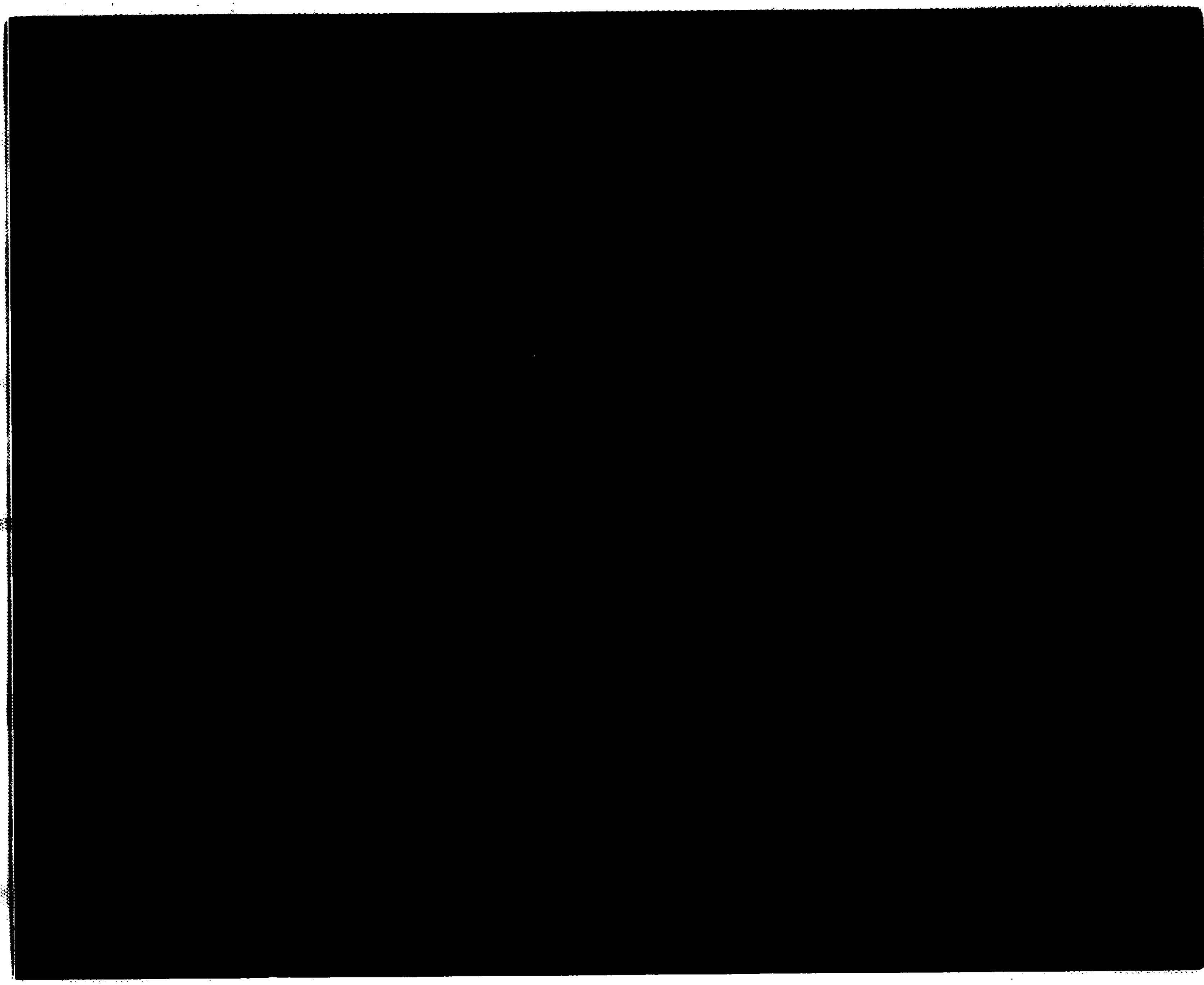

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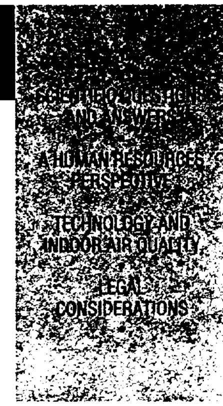

A HUMAN RESOURCES PERSPECTIVE – EXECUTIVE SUMMARY

SMOKING IS ONE ASPECT OF THE TOTAL INDOOR ENVIRONMENT

Balancing the shifting requirements of employees and management requires the special skills of human resources managers working closely with other departments to develop a workable smoking policy.

THE WORKPLACE: BLENDING HUMAN AND TECHNICAL FACTORS

With one-third of our time spent at work, a productive workplace recognizes individuals' varying requirements for a reasonable degree of flexibility and control over technical factors while accommodating personal preferences.

INDOOR AIR QUALITY IS MORE THAN MEETS THE EYE

While smoking is often perceived as the cause of poor indoor air quality, visible accumulation of tobacco smoke is usually evidence of a more pervasive problem — inadequate ventilation.

HUMANS AND HIGH TECH TERRAIN FORM A WORKING PARTNERSHIP

In the 1980s, the expansion of the white collar workforce led to extensive use of ergonomic designs in furniture, equipment and office planning. Whether it is the ability to adjust their chairs for pitch and height, or to block out unwanted sounds, or to select from more than one possible light source, giving employees a choice has come to play a larger role in managing today's complex workplace effectively.

DEVELOPING A WORKABLE SMOKING POLICY IS A PROCESS OF INCLUSION

A reasonable policy recognizes and respects the diversity of all employees while being compatible with accepted customs, individual preferences, work requirements, local culture and applicable laws.

SO WHAT ARE THE VARIOUS POLICY OPTIONS?

Each workplace can develop a policy which suits it best — unrestricted, restricted, designated rooms or even a ban. The latter, of course, does not reflect a spirit of inclusion and mutual respect.

ACCOMMODATING SMOKING IS A PRACTICAL GOAL THAT CAN BE ACHIEVED

Smoking accommodation is an achievable goal that integrates people, policy and practical technology.

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WORKPLACE SMOKING: ONE ASPECT OF THE TOTAL INDOOR ENVIRONMENT

Human resources professionals deal with difficult issues on a daily basis, regularly balancing the shifting requirements of employees and management in today's business climate.

One of their many challenges is workplace smoking. While some employees may find it annoying, others wish to smoke. Conflicts between the two groups can lead to unnecessary discord, low morale and reduced productivity.

Sometimes, regulations and laws govern where smoking is permitted; however, a common misconception is that any smoking regulation constitutes a ban. Actually, in most instances, a good deal of discretion and latitude remains with the employer. Working closely with the legal representative, building or facility management and employee representation (both smokers and non-smokers), human resource managers should become thoroughly familiar with the laws governing smoking accommodation as well as the technical options available to them in implementing the policy selected.

While smoking is only one of many factors affecting the workplace, it represents a unique challenge. To understand the complexity of workplace smoking, it is desirable to place it in the context of the total indoor environment in which we find ourselves.

THE WORKPLACE: BLENDING HUMAN AND TECHNICAL FACTORS

As much as 90 percent of our lives is spent indoors — and about one-third of that time is spent at work. For most of us, this means an office. More than a place where people work, the workplace must be a place that works for people.

A harmonious workplace is one in which employees can respect one another in a spirit of teamwork and mutual cooperation.

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Calling forth the best that individuals have to offer, these environments are a blend — not always so obvious — of technical as well as human factors, knowledge and common sense.

This is true throughout the employee population. From seating that flexes to accommodate the body's natural movements (ergonomics) to task-demand lighting that suits different work systems; from the baffling of distracting noise to the design of spaces for the proper number of occupants; and from the provision of comfortable thermal zones to acceptable indoor air quality, the best-managed workspaces are literally human spaces. They are designed to accommodate the requirements of an increasingly diverse workforce with different lifestyle choices, including smoking.

While banning smoking may be a quick fix to employee complaints about tobacco smoke accumulation and annoyance, a ban will neither improve fresh air ventilation nor ensure acceptable indoor air quality.

INDOOR AIR QUALITY: MORE THAN MEETS THE EYE

Although smoking is only one of many factors affecting the workplace, it receives an unequal share of the attention. Why? Due to tobacco smoke's visibility and characteristic aroma, employee complaints about indoor air quality tend to focus on smoking. But this can be misleading since the accumulation of visible tobacco smoke usually indicates a more pervasive air quality problem — namely, inadequate ventilation.

Indoor air quality actually began to diminish in the 1970s. High ceilings, operable fans and transoms over the doorway disappeared. Prompted by the escalating price of oil, energy-saving techniques became commonplace. Office buildings were constructed with sealed windows, synthetic building materials and furnishings became state-of-the-art and ventilation rates were dramatically reduced. The foundations were thus laid for diminished indoor air quality, particularly when combined with improper filtration and poor maintenance techniques. In essence, these energy-saving practices could create a false sense of

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economy if companies frequently lose appreciably more in employee sick time and lower productivity than they save in operating costs.

Any complaint about air quality in the workplace, whether or not it involves smoking, should be investigated. Human resources personnel should consult and work with facilities managers and other technical personnel to address the issue in a concerted, comprehensive fashion.

HUMANS AND HIGH TECH TERRAIN: A WORKING PARTNERSHIP

In the 1980s, the expansion of the white collar workforce led to extensive use of ergonomic designs in furniture, equipment and overall office planning. The assumption was that employees who could adjust their seating to suit their individual body needs would be less prone to inury, more comfortable and more productive.

As with the musculoskeletal system, so with the eye. Changing poor lighting into superior lighting meant suiting the lighting to the task. Acoustic design meant baffling noise so that it would muffle distracting sounds. And temperature and occupant density were planned to better accommodate the subjective preferences of different employees. Studies have shown, for instance, that the human body can detect as little as two degrees variation in air temperature.

Whether it is the ability to adjust their chairs for pitch and height, or to block out unwanted sounds, or to select from more than one possible light source, acknowledging and respecting employee choice has come to play a larger role in harnessing the talents and energies of differing individuals. This common sense approach has led to more effective management of today's complex workplace environment.

Similarly, workplace smoking can be managed in a manner that is fair and equitable to both smokers and non-smokers alike and that contributes to a more harmonious workplace.

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DEVELOPING A POLICY: A PROCESS OF INCLUSION

All employees — both smokers and non-smokers — should be part of the decision-making process when it comes to devising a smoking policy for the workplace. Although smokers are often in the minority, their legitimate lifestyle preferences should be balanced with the preferences of their non-smoking colleagues.

A reasonable smoking policy recognizes and respects the diversity of all employees while being compatible with accepted customs, individual preferences, local culture, work requirements, building design and, certainly, applicable laws.

In developing a policy, discussions should include personnel from various departments and groups, e.g., the facilities management who will have to determine the best technical option to facilitate and implement the policy, and human resources personnel who represent management and employees and answer questions that will invariably arise from any policy change. If the workplace has defined employee representation, e.g., unions, they should also be party to the dicussions. In addition, the size of the facility may influence the policy-development process.

Managing Large Facilities

A large facility requires a carefully structured operational framework. It is desirable to develop specific questions that are likely to be raised — and their answers — in implementing the smoking policy. This suggested Q&A should be provided to the human resources group responsible for resolving any conflicts that may arise — anticipating concerns and supplying answers will mitigate the difficulty in implementing any policy change in a large workforce.

A well-designed workplace smoking policy:

(a) Sets a tone of accommodation and mutual respect consistent with the philosophy of appreciating diversity;

(b) Identifies all areas of the building in which smoking is prohibited by law, ordinances or codes;

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(c) Defines the areas accessible to all employees where the guidelines apply — for example, in cafeterias, conference rooms, toilets, employee lounges, private offices, shared or open workspaces, processing and production areas, and company transportation;

(d) Specifies how complaints will be handled; and

(e) Communicates the policy to all employees in a manner consistent with corporate culture and the facility's procedures.

Managing Small Facilities

In a smaller facility, consensus amongst the workforce may provide the most effective means of structuring an approach to accommodate smoking at work. To achieve that consensus, an emphasis on fairness and equal respect for everyone's preferences is obviously important.

Other points considered are the same as those listed for the larger facility.

SO WHAT ARE THE VARIOUS POLICY OPTIONS?

Every company that elects to have a formal smoking policy can tailor one to fit its own particular workforce requirements within the constraint of building design. Following are some broad outlines of types of smoking policies:

- **Discretionary (unrestricted) smoking.** An informal understanding of courtesy and mutual respect has been and continues to be the "policy" of choice for many businesses. It is desirable to formally state even this position so there is no misunderstanding among current employees and new hires.
- **Designated (restricted) smoking areas.** While many facilities have discretionary smoking in private offices,

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they restrict in some way smoking in common areas, for example, cafeterias. These are spaces, without defined walls, that are set aside for smoking. They should be selected to utilize ventilation flow and air movement to direct air away from the non-smoking area into the smoking area, thereby minimizing the migration of smoke in the reverse direction.

A more formal policy which clearly explains where these areas are located and emphasizes courtesy and mutual respect is essential to the success of this method.

- **Designated smoking rooms.** These areas are physically separate from the non-smoking areas of the building and frequently the air is exhausted directly outside. In Scandinavia, exhausted air from smoking rooms is often returned to the common areas after passing through high-efficiency filtration.

  Again, a formal policy clearly defining where smoking can occur and emphasizing courtesy and mutual respect is desirable.

All workplace smoking policies should be supported by the most appropriate technical options. Some of these options are described in a companion piece entitled *Technology and Indoor Air Quality.*

Regardless of the policy chosen, human resources personnel are ideally suited in both training and temperament to place the emphasis on policies of inclusion, courtesy and mutual respect. These form the cornerstone of effective policy management for a productive work environment. An example of a policy which reflects this spirit of accommodation is included on the following page.

While a total ban is a policy option, we believe it is the least desirable one especially when other options — coupled with appropriate technology — can accommodate the preferences of both smoking and non-smoking employees.

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ACCOMMODATING SMOKING: A PRACTICAL GOAL THAT CAN BE ACHIEVED

With the advent of the twenty-first century, advances in technology will create work environments that look and feel very different from those we have become accustomed to in the past. They will bring with them new opportunities, a desire for greater individual control over personal workspaces, and the technology to achieve that flexibility.

We recognize the complexity of issues facing management today, including the wide range of concerns regarding smoking in the workplace. We realize that some people may find smoking annoying, while others, about one quarter of the population, prefer to smoke. We believe both can be reasonably accommodated and differences between individuals should be resolved in a spirit of cooperation and common sense, marshaling technical resources as needed and where practical. Smoking accommodation is an achievable goal that integrates people, policy and practical technology.

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A GUIDELINE TO ACCOMMODATING SMOKING

Statement of Purpose

[Company Name] respects equally the rights of non-smokers and smokers within our workplaces. We encourage employees to show courtesy and mutual respect in accommodating their colleagues' wishes to smoke or not to smoke. We endeavor to create and sustain acceptable indoor air quality in our workplaces whether or not smoking occurs. It is our intention to minimize annoyance and to foster a cooperative and productive work environment.

Smoking Restrictions

- All Facilities

  Each facility should identify those areas in which smoking is prohibited by applicable law, ordinance, regulation or code.

- Factories and Production Facilities

  Smoking is prohibited in all areas where it is a fire hazard or interferes with the manufacturing process.

Smoking Accommodation

- Private Offices

  Employees may smoke in their own offices, but should seek the occupant's permission before smoking in another employee's office.

- Common Work Areas

  If an employee is annoyed by tobacco smoke in the air, he or she should first speak to the smoker and seek an accommodation through discussion. If the employees cannot reach a mutually satisfactory arrangement, they should discuss the issue with their supervisor. The supervisor or manager is responsible for considering the preferences of each employee. The responsible human resources staff should be consulted to ensure consistent accommodation decisions and that appropriate steps are taken regarding the indoor work environment.

- Conference Rooms and Training Rooms

  Participants in conference room or training room meetings should show courtesy to each other while smoking during meetings. If a participant is bothered by another's smoke, he or she should seek seating to minimize the annoyance. If a meeting is non-smoking, smoking breaks should be provided.

- Cafeteria

  Smoking is permitted in all dining areas except in the section designated as a non-smoking area. Employees will refrain from smoking while in a designated non-smoking area.

- Company Vehicles and Aircraft

  Smoking is permitted in company vehicles and in company aircraft except when restricted by regulation. We expect smoking and non-smoking colleagues to be especially mindful of each other's preferences when travelling together in these confined spaces.

- Smoking Areas and/or Lounge

  In factories, production facilities and other areas where smoking is prohibited, well-ventilated and convenient areas should be provided for smoking during employee breaks.

A Final Note

Smoking, like other activities pursued in a social context, may bother some people. [Company Name] believes that courtesy and mutual respect of other's preferences can resolve differences over smoking. We expect each of our employees to exhibit a spirit of reasonable accommodation in dealing with this matter.

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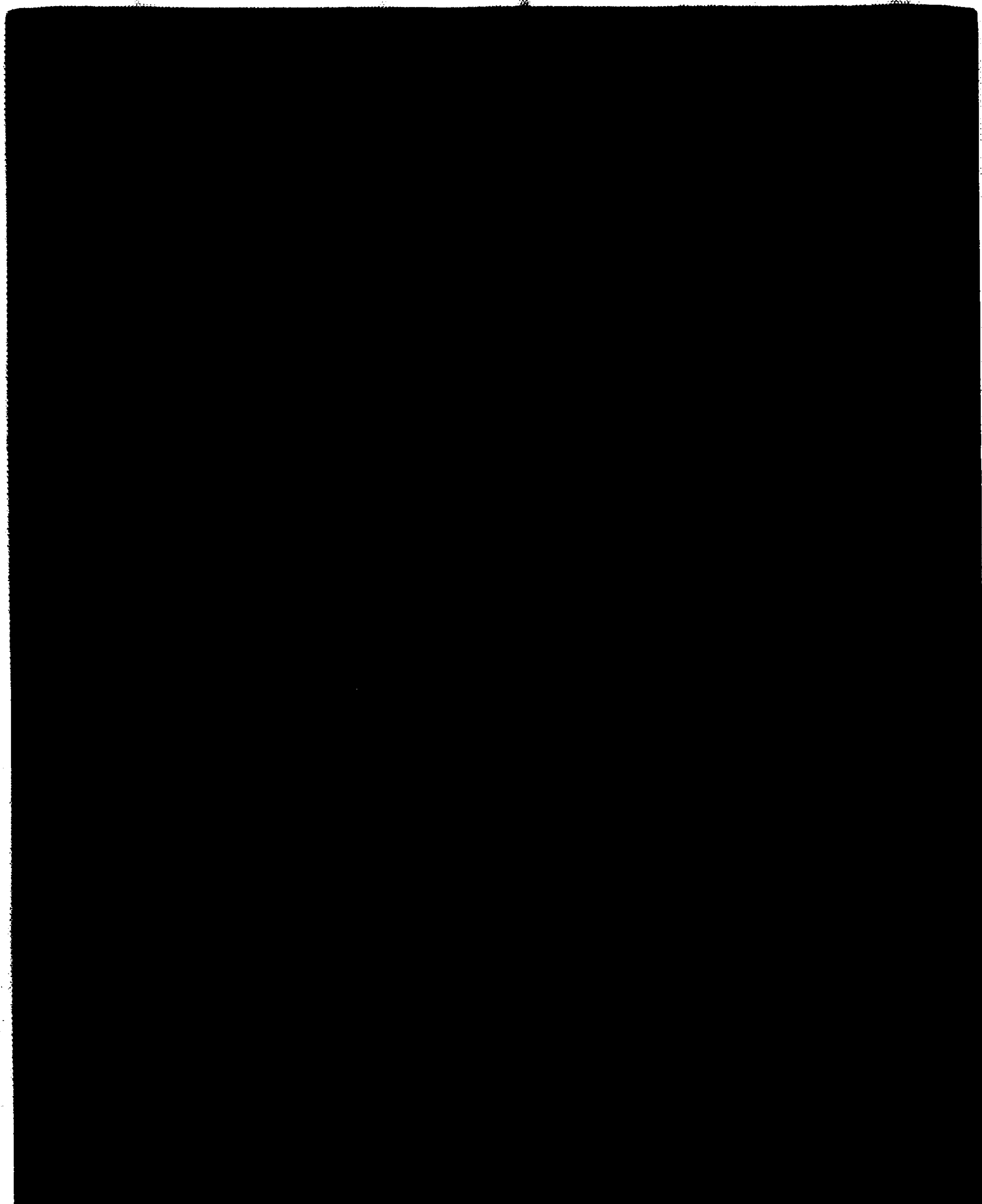

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SCIENTIFIC QUESTIONS AND ANSWERS
A HUMAN RESOURCES PERSPECTIVE
TECHNOLOGY AND INDOOR AIR QUALITY
LEGAL CONSIDERATIONS

TECHNOLOGY AND INDOOR AIR QUALITY – EXECUTIVE SUMMARY

ENGINEERING AND TECHNOLOGY PROVIDE GOOD NEWS FOR EMPLOYERS

Improved indoor air quality (IAQ) is an achievable goal through a variety of basic engineering principles and technologies, usually at low cost.

WHAT HAPPENED TO THE INDOOR ENVIRONMENT?

Energy-saving building techniques of the '70s and '80s, lower ventilation rates, and the use of more synthetic materials in the modern office have set the stage for poorer air quality.

A BUILDING SYSTEMS APPROACH IS EFFECTIVE AND PRACTICAL

Engineering and advanced technology with an emphasis on proper ventilation can provide improved IAQ for all buildings, whether or not smoking occurs.

DEFICIENT BUILDINGS AND SMOKING: WHAT'S AN OWNER TO DO?

Enhancement of the internal environment is a cost-beneficial investment which can result in higher productivity. Possible solutions range from restoring air handling systems to their original potential — to extending their capabilities with advanced technologies. By first addressing indoor air quality, decisions about accommodating smoking can then reflect carefully thought out policy discussions — rather than a hasty, but inappropriate, response to air quality complaints.

ACCOMMODATING SMOKING: WHAT'S A TENANT TO DO?

Dialogue with the building management is essential to ensure that cost-cutting measures aren't reducing air quality in a tenant's space and that tenant-proposed smoking accommodation can be achieved. Usually building management is pleased to work with tenants to their mutual benefit.

TECHNOLOGY CAN COMPLEMENT ANY POLICY

Buildings vary dramatically in size, design, building materials, age, geographic location and the preferences of their occupants. Numerous technical options exist to complement any smoking policy — in any workplace environment.

TECHNICAL OPTIONS PROVIDE REASONABLE ACCOMMODATION FOR ALL

Occupants in buildings with adequate ventilation generally have few complaints about air quality or smoking. Most companies would prefer to accommodate smokers while being responsive to the wishes of non-smokers. Engineering and technology provide the options to do both: improve air quality *and* accommodate smoking.

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ENGINEERING AND TECHNOLOGY: GOOD NEWS FOR EMPLOYERS

As a major employer, we have literally thousands of employees in buildings that vary in age, design, construction materials, number of occupants, geographic locations, and changing design usage.

Some facilities we own, making us a typical building owner. Others we lease, giving us experience as tenants. In all cases we have the responsibility of an employer. Thus, we share the same concerns as virtually any other company operating in today's climate of increasing awareness of indoor environmental issues, i.e., effectively balancing the interrelated factors of people and their environment with the issues of cost, productivity and corporate performance.

In addition, as a manufacturer of tobacco products, it is hardly surprising that we have sought out various options to address the workplace smoking issue. *Fortunately, engineering and technology provide options to improve air quality and accommodate smoking.*

There are many factors which contribute to a productive workplace environment. While the impact of lighting, noise, occupant density, ergonomics, and job related stress cannot be minimized, this discussion will focus first on achieving and maintaining acceptable air quality and then on the options available to accommodate smoking in the workplace.

The ideas presented in this publication are intended to review some of the options available and should be discussed with your own technical professional or a contractor who is qualified to address indoor air quality concerns. They should be familiar with the various engineering principles and technologies available to provide solutions to specific preferences and workplace environments. Implementation should be in compliance with applicable laws, regulations, codes and ordinances.

WHAT HAPPENED TO THE INDOOR ENVIRONMENT?

Let's look first at the changes that have occurred in the indoor environment over the last twenty years, what effect they have

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had on the quality of that environment and then what can be done about it.

Prompted by the escalating price of oil in the 1970s, energy saving techniques became commonplace in building design and operation. Office buildings were constructed with sealed windows and ventilation rates were dramatically reduced either in original design or in operating practices. At the same time, more synthetic products were introduced for use in building and furnishing materials, and high tech office equipment such as copiers and computers became commonplace.

The foundation was thus laid for diminished air quality, particularly when combined with improper filtration and poor maintenance. Under these conditions, many building occupants will begin to exhibit a broad range of physical reactions such as headaches, coughs, sinus problems, nausea, eye irritation, shortness of breath and fatigue. All of these can contribute to reduced productivity and increased absenteeism. The term "Sick Building Syndrome" has been applied to these symptoms which can be significant for a person while in the building, but disappear over the weekend or when the employee is absent from the building.

Certainly, in buildings with inadequate ventilation, insufficient filtration or poor operating practices, tobacco smoke will accumulate along with all other air-borne constituents present as a result of the by-products of humans themselves, their activities, emissions from furnishings, fixtures, fittings, office processes, and bacterial and fungal contamination.

A major difference, however, is that tobacco smoke is visible and has a characteristic aroma. The focus may be on just the tobacco smoke when it should be on the overall workplace environment. Fortunately, basic architecture and engineering principles, as well as advanced technologies, are available to provide acceptable air quality in virtually all buildings, whether or not smoking occurs.

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A BUILDING SYSTEMS APPROACH: EFFECTIVE AND PRACTICAL

Based on available data, we believe that a building systems approach, with an emphasis on proper ventilation, offers the best and most practical solution to indoor air quality issues, including smoking. This approach requires adherence to minimum environmental guidelines in the design, operation, and maintenance of a building. Specifically:

- **Adopt an adequate ventilation rate**, preferably 15-20 cubic feet per minute (cfm) per person of outside air for the building in general, with a minimum of 20 cfm per person in office areas.

- **Assess ventilation** and perhaps supplemental filtration requirements for special-use areas where demand for ventilation may be high, such as in printing and copying rooms, toilets, kitchens, smoking rooms, laboratories, conference rooms, auditoriums and cafeterias.

- **Install correctly and maintain efficient air filtration** systems with filters of at least 40% efficiency for fine particles.

- **Ensure good hygiene practices** of all ventilation system components.

- **Select knowledgeably all materials and furnishings** for the building. Request information on chemical emission rates from materials supplied by manufacturers and their products' ability to inhibit microbial growth.

- **Require appropriate janitorial services**, both in the products used and the cleaning practices and equipment employed.

- **Implement a pro-active inspection and monitoring** program addressing indoor air quality.

- **Promote education and training** of the building's maintenance and operations staff in the fundamentals of indoor environmental issues.

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QUALITY INDOOR ENVIRONMENT: GUIDELINES AVAILABLE

There are already many appropriate guidelines for most of these concepts published by, among others, the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).[1-7] We support and encourage their use.

A particularly helpful standard is ASHRAE 62-1989, *Ventilation for Acceptable Indoor Air Quality* which provides for both a design and performance method in assessing acceptable air quality.[2] It was developed as a consensus document and was based on "real life" feedback from architects, engineers, consumer organizations, health officials, medical researchers, building owners and operators. Their experience showed that 20 cfm of outside air per person as a ventilation rate in an office setting was effective in controlling indoor pollution from all sources. This amount of air exchange takes into account health variations among people and their varied activities, including a moderate amount of smoking.

For a variety of reasons some buildings, such as those built in the '70s and early '80s, with only 5 cfm, do not meet this ventilation rate. The same standard (62-1989) provides an alternative performance method for accessing acceptable air quality. Thus, any existing building can be evaluated for indoor air quality and compared with standards. If the building meets these targets, and there is no significant level of complaints, then no further ventilation modifications should be required.

DEFICIENT BUILDINGS AND SMOKING: WHAT'S AN OWNER TO DO?

In the case of buildings that fail to meet either the ventilation rate or air quality standards, it is likely there will be complaints and, eventually, absenteeism and/or illness. Often, complaints

1 All ASHRAE material available from American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. - 1791 Tullie Circle NE, Atlanta, GA 30329.
2 ASHRAE Standard 62-1989, *Ventilation for Acceptable Air Quality.*
3 ASHRAE Standard 55-1992, *Thermal Environmental Conditions for Human Occupancy.*
4 ASHRAE Standard 52-1986 (Reaffirmed 76) *Methods of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.*
5 ASHRAE Guideline 1-1989, *Commissioning of HVAC Systems.*
6 ASHRAE Guideline 4P exists in the form of a public review draft dated 1992, *Preparation of Operating and Maintenance Documentation for Building Systems.*
7 ASHRAE Standard 52-1976 *Methods of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.*

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are focused on smoking. If there is smoke accumulation and people are feeling uncomfortable, they quite understandably blame what they can see. However, smoke accumulation is a marker for a more pervasive problem — inadequate ventilation.

Whether the driving force is to boost occupant comfort, increase productivity or reduce risk of possible IAQ litigation, many building owners and employers find a positive program of enhancement of the internal environment a desirable and cost beneficial investment, regardless of the smoking accommodation issue.

FIRST, Make the most of what you have.

- *Maximize the existing ventilation rates* during all periods of occupancy.
- *Use the highest grade filters* within the air pressure drop constraints of the existing supply fans.
- *Establish good hygiene and maintenance procedures* for the heating, ventilating and air conditioning system with particular emphasis in all areas that may get wet. After cleaning, antimicrobial surface coatings are available for certain troublesome areas.
- *Check air distribution effectiveness* to all areas of occupancy. Rebalance the air supply and exhaust if necessary. Controls for regulating air volumes should be evaluated and, if necessary, recalibrated precisely and often to maintain reliability. In future renovations consider direct digital controls for increased reliability.
- *Adopt IAQ awareness* in all future building operations and renovations.

SECOND, Supplement ventilation in special use areas.

- *Provide supplemental, fan-powered filters* to trap particulate or gaseous emissions. There are many packaged filtration devices on the market, some with exaggerated claims of efficiency. For comparative purposes request efficiency ratings for particulates based on the Atmospheric Dust Spot Test in ASHRAE Standard 52-1976.
- *Select adsorbent filters* using activated carbon or equivalent, recognizing that to maintain an acceptable life of the adsorbent filter material an estimated 20 lbs. of adsorbent should be used for each 1,000 cfm of air being cleaned.

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Source: https://www.industrydocuments.ucsf.edu/docs/qklm0000

THIRD, Modify and/or retrofit with advanced technologies if required.

- *Economizers*

  Over long periods of the year the building can be operated more efficiently by the judicious use of "free cooling" provided by an economizer cycle. Almost all buildings require some cooling, even in winter. Whenever outside air conditions fall within predetermined bands of temperature and humidity, the building can be switched to 100 percent outdoor air or large quantities of outdoor air mixed with return air. The net result is lower energy costs and dramatically boosted ventilation rates.

- *Energy Recovery Ventilators*

  Energy recovery units transfer heat from the outgoing air to the incoming airstream (and the reverse in summer) thereby reducing the energy costs. There are three basic types: the flat plate core, which can be either counter flow or cross flow; the heat pipe types described below; or the rotary wheel core exchanger. In the latter case, both the exhaust and outside air streams pass through the same heat transfer matrix. The rotating heat transfer surface continually moves from one airstream to the other, transferring energy from the warmer stream to the cooler one.

  Packaged systems of all three types are available from major air conditioning supply companies offering efficiency rates of typically 70 to 80 percent.

- *Humidity Reduction*

  Apart from improving occupant comfort and reducing the incidence of bacterial and fungal contamination, reducing the relative humidity in hot climates can yield energy savings. In humid conditions, 40 to 50 percent of the heat load across the coils involves latent cooling – the energy expended in condensing moisture out of the air.

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Molecular Sieve Desiccant

New developments in desiccant technology, including molecular sieve devices, are proving to be very effective in removing the moisture from the incoming air and transferring it to the outgoing air without transferring pollutants between the air streams. This practice allows the existing chill coils to deal primarily with sensible cooling instead of latent cooling, thereby dramatically increasing their capacity.

Heat Pipes

Pipes containing a refrigerant are placed in front of the chill coils. A second section of pipe is positioned in the supply-air stream leaving the coils. The pipes are inter-connected forming a closed loop. When warm, humid outside air impacts on the first pipes, it causes the refrigerant to boil, thereby taking heat of evaporation from the warm air. This cools the air and helps condense out much of the moisture. The original chill coils now sub-cool the air, wringing out still more moisture.The cooler air now meets the second pipe and the process is reversed.The refrigerant condenses, while at the same time the supply air is warmed back to its design temperature, resulting in still dryer air. The net result is higher ventilation rates from installed equipment and much lower humidity in the occupied space.

Whether the optimization of existing equipment, use of supplementary filtration devices or employment of novel technologies for energy recovery and/or humidity control is preferred, the goal is to bring the building up to its optimum potential. Thereafter, decisions about smoking accommodation can reflect policy discussions rather than a quick but inappropriate response to IAQ complaints.

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SMOKING ACCOMMODATION: WHAT'S A TENANT TO DO?

Some tenants abdicate all decisions about air quality to their landlords. This can be a short-sighted policy. While most landlords have tenants' comfort and satisfaction high on their list of priorities, others exploit such passive tenants. Savings on ventilation costs and reduced maintenance and operating budgets can boost a landlord's income while the tenant air quality suffers.

Tenants should open a dialogue with the building manager and request specifics on ventilation flow rates, filtration standards and heating, ventilating and air conditioning inspection protocols. In the case of tenants designing and financing their own smoking room facilities, it is important that the latter be integrated into the total building system.

A decision to breach walls or penetrate roofs for exhaust capacity and link up exhaust ducts with existing exhaust shafts or dedicated exhaust systems would require permission of the landlord. Obviously, cooperation is mutually beneficial. From the landlord's perspective, loss of smoking privileges could lead to loss of tenants. Also, careless smoking policies of one tenant may impact adjoining tenants.

Building owners recognizing these dilemmas invariably benefit when they recognize that their responsibility is to present a solution to a problem, not an ultimatum. Indeed, some multi-tenant buildings now enjoy the use of tenant lounges provided by forward-thinking property managers. In either case, whether the solution is the establishment of private smoking rooms or central tenant lounges, the catalyst is communication. One party communicates its objective to the other party who listens with empathy and acts with common sense.

TECHNOLOGY CAN COMPLEMENT ANY POLICY

Most workforces represent a diverse population. The buildings in which they work vary dramatically in size, design, building materials, age and geographic location. Inevitably, there are numerous technical options which will complement any smoking policy in any workplace environment. A particular policy choice will then guide the selection of the most appropriate technical option to support that policy decision.

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Although these policies will vary, they must comply with national or local laws, ordinances, regulations and codes prohibiting and/or restricting smoking, and be compatible with accepted customs, preferences, work practices and local culture.

Usually, a policy will fall within one of the following three categories. Whichever policy best suits a specific workplace, it is desirable to specify and communicate the policy parameters appropriately.

- *Discretionary (unrestricted) smoking.*

  An informal understanding of courtesy and mutual respect has been and continues to be the "policy" of choice for many businesses. It is desirable to formally state even this position so there is no misunderstanding among current employees and new hires.

- *Designated (restricted) smoking areas.*

  While many facilities have discretionary smoking in private offices, they restrict in some way smoking in common areas, e.g., cafeterias or open plan offices. These are spaces without defined walls that are designated for smoking. These designated areas should be selected to utilize ventilation flows, air movements, and the basic laws of physics.

  A more formal policy which clearly explains where these areas are located and emphasizes courtesy and mutual respect is essential.

- *Designated smoking rooms.*

  These areas are physically separate from the non-smoking areas of the building and are most likely exhausted directly outside. However, several locations in Scandinavia are now successfully using enclosures that provide high efficiency filtration and adsorption before returning the cleaned air to the common use areas.

  Again, a formal policy clearly defining where smoking can occur and emphasizing courtesy and mutual respect is desirable.

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DISCRETIONARY SMOKING: GOOD VENTILATION AND COMMON SENSE

If buildings have adequate ventilation and experience no significant complaints of air quality issues – why change? Discretionary smoking is practiced in many buildings.

Used air, though returned to the main air handling equipment, can be filtered and diluted to such an extent that it meets acceptable outdoor air standards. Since this standard is based on the National Primary Ambient Air Quality Standards for outdoor air as set by the U.S. EPA, it is unreasonable that such supply air to the building could be judged to be unacceptable. In essence, if the filtration and dilution process provides supply -air quality equivalent to the outdoors – so-called fresh air – then no further refinements should be necessary.

DESIGNATED SMOKING AREAS: ENGINEERING PRINCIPLES AT WORK

With some thoughtfulness in the selection of the smoking areas with respect to prevailing ventilation conditions, a policy of designated smoking areas works very satisfactorily.

Physical grouping of smokers and non-smokers in discrete areas reduces non-smoker exposure to tobacco smoke and frequently obviates the need for further changes. In selecting this option it is important to utilize the prevailing air currents and routes of supply and exhaust of the air. Whenever feasible, the smoking area should be concentrated nearer to the exhaust grilles with the non-smokers closer to the supply grilles. Providing the exhaust systems are sized properly, such an arrangement will ensure that the air movements will be diverted from non-smoking areas to smoking areas and then to room exhaust. This minimizes the migration of tobacco smoke from smoking to non-smoking. Thereafter, the exhaust air should exit the building or, provided that it is filtered and diluted to meet nationally agreed outdoor air quality standards, it can be recycled back to the air supply system.

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SMOKING ROOMS: APPLYING TECHNOLOGY

Conventional Rooms

Dedicated smoking rooms can be set up in most buildings. The most desirable location for the room in larger buildings is in the core area. This area usually contains other special use areas such as copying rooms, kitchens, toilets, etc. that are already equipped with exhaust capacity. Thus, integrating the smoking room exhaust to the existing exhausts can be accomplished at reduced cost..

ASHRAE's suggested ventilation rate for a dedicated smoking room is 60 cfm/person based on an occupancy rate of approximately 15 square feet per smoker. This equates to 4 cfm of exhaust air per square foot of room area. In sizing a dedicated smoking room, multiply the area of the room in square feet by four to yield the required capacity of the exhaust fan in cubic feet per minute.

In retrofitting an existing office or room to function as a smoking room, the following steps are suggested:

- Disconnect and seal off any existing return air grilles.
- Install, preferably in a central location of the ceiling, a designated exhaust system tied in to a central exhaust serving the building, e.g., toilet exhausts. Alternatively, the discharge can be ducted to any existing exhaust shafts or when feasible, directly through the wall to the exterior of the building. Most authorities permit linking dedicated exhaust systems together in a common duct, but individual building owners should check with their local authority for regulations to avoid contravening local building codes.
- In the case of heavy utilization of the smoking room, consider installing local supplementary filtration. High efficiency media filters or electrostatic precipitators are recommended. The capacity of such room filters should be selected to ensure that the total volume of room air is filtered every five minutes.

  i.e. Minimum cfm requirement of filter = Volume of Room in cubic feet - divided by 5.

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- In providing exhaust air capacity at a rate of 4 cfm/square foot, the smoking room will develop a negative air pressure with respect to adjacent areas. Thus, air flow will be from the adjacent areas into the smoking room, precluding the release of smoke out into the adjacent areas. The movement of air from the higher pressure areas to the negative pressure areas is defined as transfer air. The use of transfer air for smoking rooms, toilets, etc. is recommended by ASHRAE to preclude the movement of annoying odors and other noxious substances into other occupied areas.

Innovative Controls

Dedicated smoking rooms are subject to wide variations in occupant use. Sizing a lounge for its maximum design occupancy and peak loads results in the installation of exhaust fans or fan-powered filtration systems that are oversized whenever the room is at partial load or indeed when it is not in use.

Several innovative designs of sensors can be incorporated into the control equipment to regulate the fan operation and maximize energy savings in these lounges. Occupancy sensors can be programmed to turn the fans and lights off when the rooms are unoccupied. Gas sensors measuring carbon dioxide concentration and volatile organic sensors that monitor organic vapors, including tobacco smoke, are also available and can be integrated into the fan control circuits to regulate the exhaust rates in response to demand loads.

High Efficiency Filtration Rooms

Popular in Scandinavia, and now offered worldwide, are individually tailored smoking cubicles equipped with extra high efficiency filtration units. Swedish manufacturers prefabricate several models of smoking cubicles, each equipped with electrostatic precipitators using disposable cellulose electrodes mounted in series with activated charcoal filters. Alternatively, the filtration systems are mounted above suspended ceilings of a typical office, and air is then redirected back to the smoking room. A very effective variation of this design is the use of the filtered air to produce an air curtain across the entrance to the smoking room.

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Similar designs are now appearing in the U.S. Filtration units with 95 percent filtration efficiency for particles as small as 0.3 microns, or even super-efficient systems using HEPA filters with efficiencies above 99.97 percent at 0.3 micron size particles are available. Options include the use of activated charcoal or other adsorbents for removing volatile organic components and tobacco odors.

Of particular interest are the special chemisorbant blends of media such as activated charcoal and alumina pellets impregnated with potassium permanganate, or zeolite materials, that are especially effective at removing the odiferous components of tobacco smoke.

Displacement Ventilation Designs

Displacement ventilation occurs when the ventilation air flows past the contaminant source and sweeps the contaminant towards an exhaust. In the case of smoking rooms, the most effective route is to channel all the supply air from floor level and allow it to move vertically through the room, exhausting at ceiling height. This ensures that all the substances present in the indoor air, such as dusts, skin scale, tobacco smoke, body odors, microbes, exhaled breath, etc. will also rise vertically above the room occupants and be removed into the exhaust located in the ceiling. Since most of the emissions of pollutants from human activities are warm relative to the surrounding air, there is a natural tendency for them to move upward on thermal currents. The upward flow of ventilation air speeds up this process in displacement ventilation designs.

Two options of smoking room designs are suggested. One requires a raised floor air supply system similar to the classical computer room design. The other can be installed in any existing area using specially designed low velocity air diffusers. These designs are referred to as the Filtered Air Control Technology (FACT) and the DisplaceVent System.

FACT

The FACT system, designed by Philip Morris engineers, provides a constant volume of supply air, moving at a rate of ten feet per minute through a perforated raised flooring system. This velocity of air moving uniformly upwards throughout the room displaces the room air in a piston or plug flow, vertically upwards. The displaced air carries with it all airborne substances which are

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removed via the exhaust/return air system. Typically 50 percent of the air is exhausted, the other 50 percent constitutes return air. Outside air is mixed with the return air and the mixture is scrubbed via high-quality electronic air cleaners and activated charcoal-based gas phase filters. The air is then conditioned via conventional heating and cooling coils before being returned to the subfloor to start the process over again.

Since the design is based on a raised access floor system, this design will not be practical in all buildings. However, when new construction or major remodeling is planned, this design is worthy of consideration.

DisplaceVent

This is classical displacement ventilation. The supply air enters the room at floor level through specially designed low velocity diffusers. The air is delivered several degrees cooler than the room air causing it to spill across the floor forming a "lake" of clean air. The air will rise naturally as it starts to warm. Any heat sources in the room, including people, create a "heat bridge" towards the ceiling. Indeed, the supply air is induced across the surface of the room occupants forming a plume above them moving to the ceiling where the exhausts are located. This means that clean air is continually drawn past the breathing zone of the room occupants. This concept is effectively a self-regulating form of demand ventilation. The more people present in the room, the faster the upward air flow due to increased thermal loads.

These displacement ventilation techniques can provide greater ventilation effectiveness than in conventional mixing type ventilation where both supply and return air are delivered or removed from the space via the ceiling. Indeed, throughout Europe and Scandinavia, many buildings including commercial offices are choosing such displacement ventilation techniques for all occupied spaces whether or not smoking occurs.

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TECHNICAL OPTIONS PROVIDE REASONABLE ACCOMMODATION FOR ALL

Many employers and building owners have already introduced smoking policies. Those that have not, should. In general, buildings that have adequate ventilation usually have few complaints about air quality and/or smoking.

While some companies have smoking bans, most prefer a more moderate approach in attempting to accommodate smokers while being responsive to the wishes of non-smokers. Fortunately, engineering and technology provide options to improve air quality and accommodate smoking.

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There are numerous products and services available to facilitate the engineering and technology described in this brochure. We gratefully acknowledge the technical information provided by the following companies:

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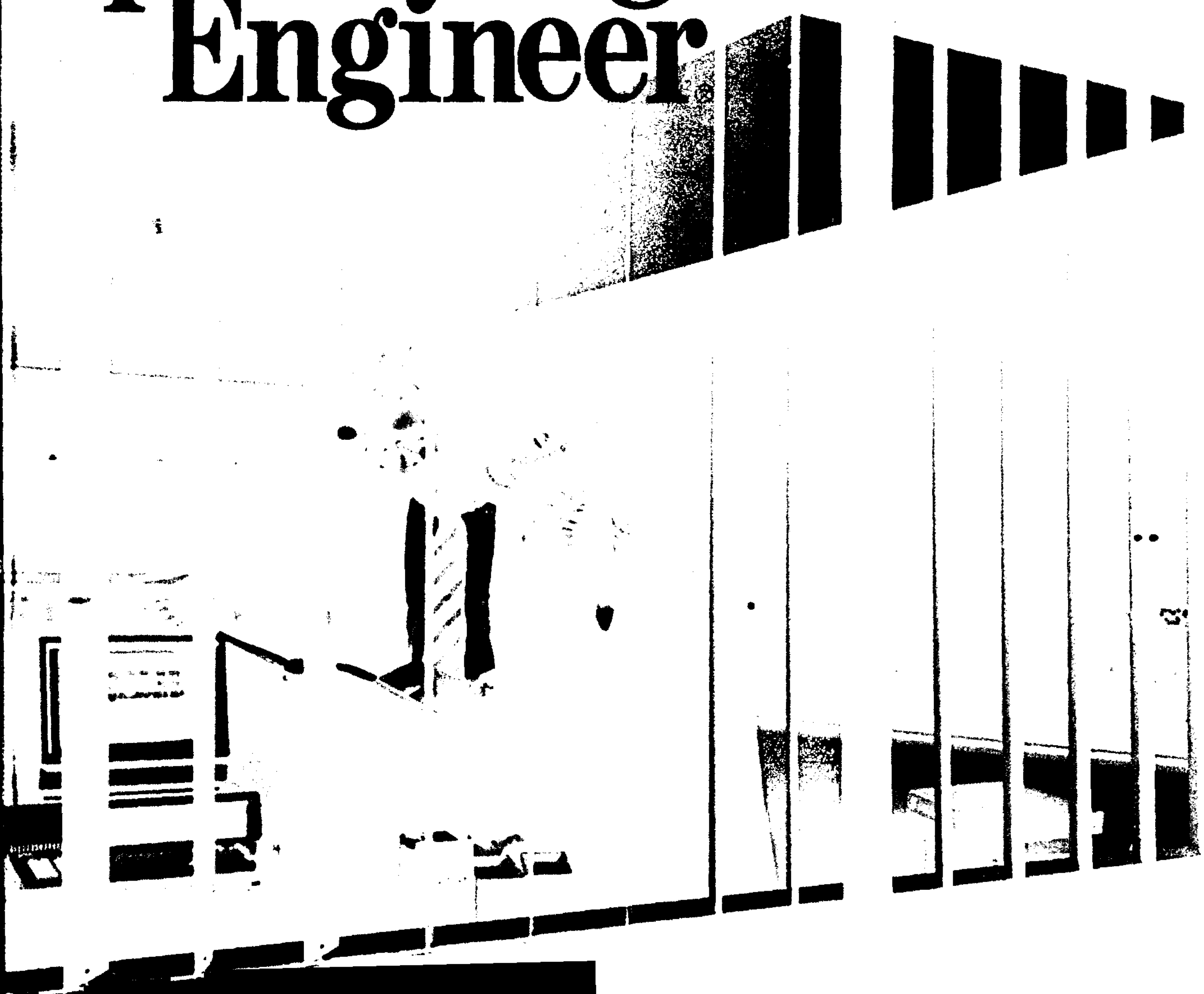

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The New Horizon

Indoor Environmental Quality

2023478736

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Designing an indoor environment that is both comfortable and functional can be done with efficiency and style from the perspective of the new horizon: indoor environmental quality.

Not just an assembly of design parameters, the new horizon of indoor environmental quality means designers must grasp the total effect of these factors on the occupant.

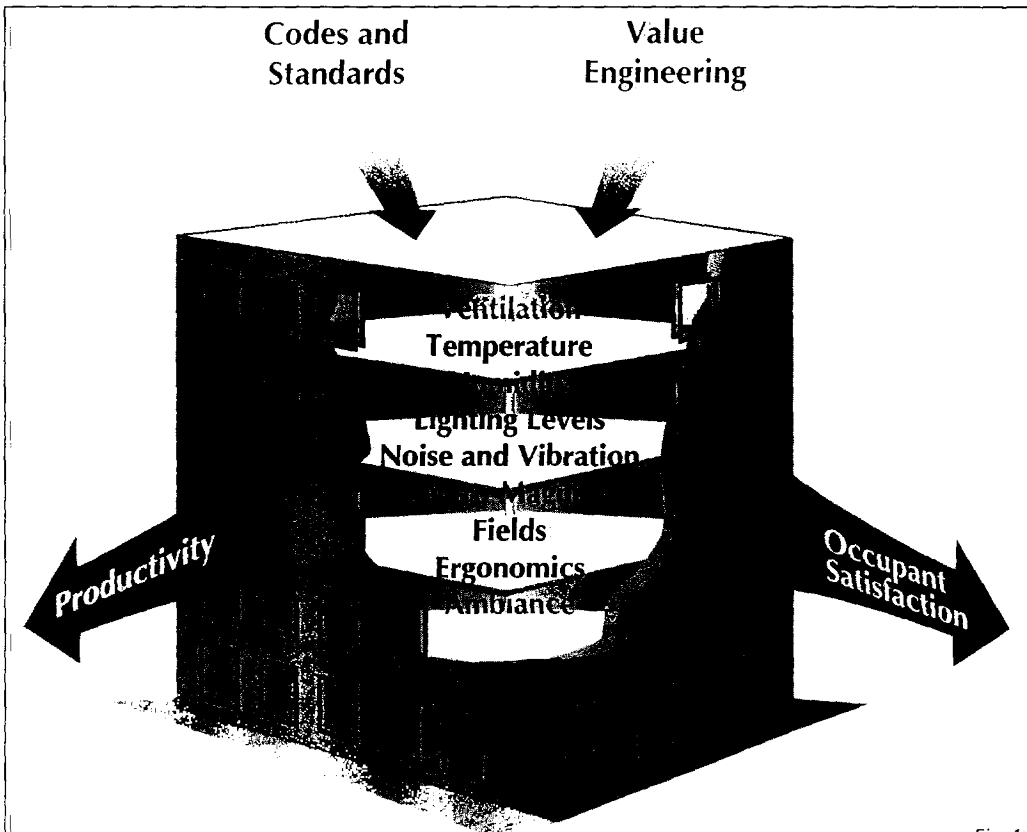

Fig: 1

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The New Horizon

Change is in the wind. Change in the manner in which people use buildings. Change in the expectations people have of their workplace environment. Change in the way buildings must be designed and maintained to meet new demands. For engineers charged with designing new and retrofit office construction projects, the force of change creates a new horizon: total indoor environmental quality.

Like other major trends in office construction, the shift of focus to the broad perspective of indoor environmental quality will produce a complete rethinking of how buildings are planned, designed, built, started-up, and operated. And, like other major trends, indoor environmental quality will not replace past practices, but will extend and overlay the positive aspects of past building practices. Indoor environmental quality will not discard the efficiency improvements gained in the move for energy conservation of the past twenty years, as many predict. Instead, it will absorb the lessons learned by engineers through their energy experience and integrate efficiency into the most basic systems and equipment from earliest planning to operations.

Offices of today and the future will need to meet increasingly stringent demands for proper design and management to achieve good indoor environmental quality, which includes such issues as ergonomics, light, noise, decoration, ambiance, and organizational and personal dynamics, as well as ventilation and indoor air quality. Total indoor environmental quality means addressing the needs of the occupants, and balancing and accommodating those needs where necessary to achieve cost effective construction and operation of buildings.

Technical creativity and design finesse provide solutions for this challenge. For example, a range of positive choices is available to balance the requirements of smokers and nonsmokers in the use of indoor space. The development of methods for accommodation of smokers represents an excellent case study for developing a model of good management practice for the indoor environment.

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Understanding the Indoor Environment

Aesthetics and functionality once provided sufficient measure of the quality of the design of indoor office workspace. Engineers concerned themselves with temperature and humidity for thermal comfort, and sufficient ventilation to overcome the odors produced by human occupants. Architects and interior designers selected floorplans, furnishings and amenities to meet the budget and taste of their clients, creating an "ambiance" that suited the building and its occupants. Such criteria for quality offer part, but not all of the design parameters that will combine in determining indoor environmental quality in the future.

The emerging science of indoor environmental quality combines subjective factors, such as aesthetics, with quantifiable factors, ranging from the quality of the indoor air, to ergonomic conditions, noise and light levels. Occupant perceptions of health, safety, comfort, and productivity, once separate concerns in building design, now combine in the larger context of indoor environmental quality. Grappling with the concept of indoor environmental quality, designers must look broadly at physical and operational design parameters, integrating factors as wide-ranging as traditional issues of interior design and ambiance, setting new standards for maintainability, and even reaching subjects such as organizational and personal dynamics *(See Fig. 3)*. These factors interrelate to form a whole that yields both the perception and the reality of good indoor environmental quality.

Accommodating Smokers Under ASHRAE 62-1989

A key step in using the accommodation model for designing a high quality indoor environment is analyzing codes and standards that apply to the specific use being accommodated. While local codes may have specific requirements that apply to accommodation of smokers, ASHRAE Standard 62-1989 represents the current national standard of broadest applicability. For the present discussion, the ASHRAE Standard will be used as an example of the role of codes and standards in the process of assessing technology for the accommodation model of indoor environmental quality. Central references to designing for accommodation of smokers and non-smokers in ASHRAE 62-1989 include the following:

- **Foreword:** Provides history of the development of the ventilation standards, noting the importance of accommodating smoking, among other uses, and the changes in technology that have motivated changes in the Standard over time.
- **Section 4, Classification,** defines "Ventilation Rate Procedure" and "Indoor Air Quality Procedure" as design methodologies for determining specific requirements in varying HVAC applications.
- **Section 5, Systems and Equipment,** includes discussion of particulate filters and vapor and gas removal devices for supplemental air cleaning.
- **Section 6.1, Ventilation Rate Procedure,** prescribes the methodology for use of the ventilation rate values provided in Table 2.
- **Table 2, Outdoor Air Requirements for Ventilation,** the heart of the Standard, prescribes design outdoor air quantities and maximum occupancy levels for a wide variety of specific uses of indoor environments, including smoking lounges, and explains that the requirements were set "to account for health variations among people, varied activity levels, and a moderate amount of smoking."
- **Section 6.1.3.1, Multiple Spaces,** provides for the use of "transfer air," air which moves from one indoor space to another, to supply smoking lounges and other areas with exhaust systems.
- **Section 6.1.3.2, Recirculation Criteria,** defines the conditions under which recirculated air can be substituted for outdoor air.
- **Section 6.1.3.3, Ventilation Effectiveness,** defines a methodology for calculating ventilation effectiveness and allows for use of plug flow, or displacement, ventilation.
- **Section 6.1.3.4, Intermittent or Variable Occupancy,** defines parameters for calculating ventilation rates when the number of occupants in an area varies over time, as it does in a smoking lounge.
- **Section 6.2, Indoor Air Quality Procedure,** establishes an alternative methodology that allows ventilation rates to be adjusted to achieve effective removal of known contaminants, and to meet subjective evaluation criteria, including a specific discussion of environmental tobacco smoke.

Fig. 2

An Engineering Perspective

Elements of the building that are controllable from an engineering design and operational perspective revolve around balancing the projected uses of each space with its operating parameters. Indoor environmental quality factors, even those so remote from traditional engineering as organizational dynamics and stress, can be influenced by the plan for how each space within a building will be used, and the resulting decisions about the physical characteristics specified for it. Good design practice for achieving good indoor environmental quality begins with a space use plan far more detailed and sophisticated than those seen in past practice.

The plan for use of the space within a building designed and operated for good indoor environmental quality requires multi-dimensional conceptualization of how occupants will perceive their environment and act within it. Floorplans will be supplanted with useplans which incorporate layers of detail:

- **Basic floorplan** lays out primary use, basic building systems and amenities
- **Extended floorplan** details special uses that require upgrades to building systems
- **Occupant floorplan** lays out choices about use patterns, such as office equipment and smoking preferences, as well as anticipated times of occupancy and special uses of space
- **Air quality plan** details emission rates from various fixed sources, such as carpeting, furniture, and construction materials, as well as variable sources, such as levels of

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occupancy, smoking, and kitchen use, and how source management and ventilation will control occupant exposures

- **Maintenance plan** details how equipment will be maintained, and how sources of contamination from maintenance, such as cleaning fluids and pesticides, will be managed to minimize occupant exposure
- **Ergonomic plan** details workflow planning and how the layout of the space will accommodate ergonomic considerations to minimize physical stress points in the workplace, ranging from properly designed and adjusted chairs and desks to glare-free computer stations and acceptable levels of noise and vibration

A Model for Indoor Environmental Design

These plans incorporate traditional application of design parameters and standards at each step, providing a baseline of traditional quality assurance. But by assembling these plans into a multi-dimensional whole, the planned interior space can be evaluated for environmental stress points—locations and times in which the layout or operation of the space and its supporting systems might fail to avoid, or might actually

Table One
Indoor Environmental Quality Factors

Factor	Elements	Design Tools	Subjective & Objective Criteria	Standards and Guidelines
Comfort	Temperature Humidity	HVAC specification Zoning for use Air distribution	Individual comfort Static electricity Microbial growth	ASHRAE 55-1981, Thermal comfort; 111-1988, Test and balance; Guideline 1-1989, Commissioning of HVAC systems
Air Quality	Ventilation Chemical emissions Bioaerosols Particulates and dust	HVAC specification Filtration system Material selection Local exhaust Zoning for use Air distribution	Odors Irritation and health complaints Visible dust Scientific sampling and analysis	ASHRAE 62-1989, Ventilation; 90.1-1989 and 100.2–100.6, Energy; 52-1968 (RA76) and 52.1-1992, Filtration testing ACGIH Guidelines for the Assessment of Bioaerosols in the Indoor Environment; Industrial Ventilation: A Manual of Recommended Practice NADCA duct cleaning standards
Utility	Light levels Noise levels EMF	Lighting specifications Material selection Daylighting Work flow analysis HVAC equipment selection	Light intensity and color Glare EMF measurements Noise dba and vibration levels Aural distraction	IES Lighting Handbook ASHRAE 90.1-1989, incl. lighting; 68-1086, Fan noise testing methodology AIHA Noise and Hearing Conservation Handbook
Ergonomics	Floorplan Furniture Office equipment	Useplanning Adjustable work stations	Physical stress Relative physical position for specific tasks Individual comfort	NSC Ergonomics: A Practical Guide AIHA Ergonomics Guides OSHA proposed rulemaking
Ambiance and Human Interactives	Accessibility Decorations Floor coverings Wall coverings Fixtures Furniture Lighting Noise levels	Accommodation Lighting Color Perspective Material selection	Psychological stress Use limits Emissions Comfort Taste	BOMA ADA Compliance

ACGIH (American Conference of Governmental Industrial Hygienists) — ADA (American Disabilities Act) — AIHA (American Industrial Hygiene Association) — ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) — BOMA (Building Owners and Managers Association International) — IES (Illuminating Engineering Society) — NADCA (National Air Duct Cleaners Association) — NSC (National Safety Council) — OSHA (Occupational Safety and Health Administration)

Fig. 3

add to, the physical or psychological stress placed on building occupants. Reducing environmental stress points to a minimum, while conscientiously attempting to create an ambiance that meets the taste and budget of the occupants, provides the highest probability that a design will result in good indoor environmental quality over the many years that the building is occupied.

Developing a useplan which provides good indoor environmental quality presents a series of decisions that balance the needs of occupants and make tradeoffs to bring the plan within budget limitations. One example of occupant use, accommodation of smokers and non-smokers, offers an example of how the useplan can be valuable in design decisions basic to achieving good indoor environmental quality in new or retrofit applications. Examination of the various approaches and technologies available to engineers to design for accommodation of smokers provides a model for how to develop a useplan to set the new standards of good design and management practice for indoor environmental quality.

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Strategies for Accommodating Smokers

High-Rise Buildings

High-rise buildings present some of the most dramatic architectural statements of the twentieth century — and some of the most difficult and complex indoor environments to manage. Some of the largest high-rise complexes provide an office workplace for more than ten thousand occupants daily, while others provide a combination of office, retail and even residential uses in a single structure, reaching skyward as high as one hundred stories. With the structural challenges of high-rise construction now mastered, raising the level of indoor environmental quality provides a new horizon.

Designing an approach to accommodating smokers in a high-rise building demonstrates some of the key challenges in achieving good indoor environmental quality in the epitome of modern architecture. First, the populations of such buildings are large, and comprised of a majority of working adults. National statistics show that about twenty-six percent of the adult population of the U.S. currently smoke. In a high-rise building with ten thousand working occupants, as many as twenty-six hundred may be smokers.

Most high-rise buildings have accommodated smokers by allowing smoking throughout the building or by restricting smoking in public areas, but allowing it in tenant spaces. Recently some building managers have experimented with requiring smokers to exit the building to smoke. The impracticalities of this approach become overwhelming for some simple reasons: using our sample high-rise, and assuming smokers would exit the building an additional two to four times a day to smoke, between five thousand and ten thousand additional elevator trips would be added to the daily vertical transportation load. That adds stress to the building system and energy load. The solution also adds substantial stress to twenty-six hundred building occupants, who expose themselves to the vagaries of the outdoor environment. Alternative approaches can reduce both energy penalties and the environmental stress created by the radical solution of banning smoking indoors.

Options for an Accommodation Strategy

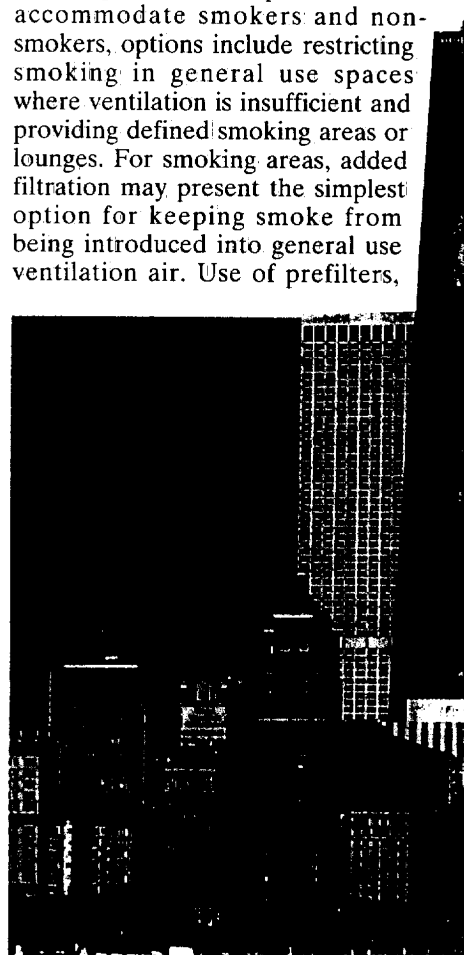
Accommodating smokers and nonsmokers in a high-rise building can be done in several ways. Three general options that can work are

- Provide sufficient ventilation based on ASHRAE guidance *(See Fig. 2)*
- Designate smoking areas, where additional ventilation, negative pressure zones, or improved filtration compensate for a concentration of smoke in a small area
- Establish smoking lounges, where separate ventilation and exhaust systems remove smoke from general ventilation

Challenges in Existing Buildings

The existing stock of high-rise buildings represents a variety of design parameters for ventilation as the standards have varied over the past decades. Some of these buildings were designed using lower ventilation rates than those suggested in ASHRAE Standard 62-1989, presenting a complex challenge for retrofit increases in ventilation. Where following the ASHRAE recommended rates may be impractical, building managers seeking to enhance indoor environmental quality may need to look at alternative approaches for improvements in air quality, including revising use patterns to fit ventilation needs, and adding filtration to improve the quality of recirculated air.

Revising use patterns is an interactive process among building management, designers, and occupants. Looking at the example of how to accommodate smokers and nonsmokers, options include restricting smoking in general use spaces where ventilation is insufficient and providing defined smoking areas or lounges. For smoking areas, added filtration may present the simplest option for keeping smoke from being introduced into general use ventilation air. Use of prefilters,



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carbon filters, and final high efficiency particulate filters has proven effective for this purpose. By using zoning of the air handling system to minimize the portion of total return air needing this advanced filtration, energy and cost penalties for this improvement to the indoor environment can be kept to a minimum.

Establishment of smoking lounges presents more specific challenges in the context of a high-rise building retrofit. High-rise buildings typically provide only minimal exhaust from occupied floors to avoid adding to the "chimney effect" that complicates all high-rise ventilation design. The existing exhaust system must be evaluated for its capacity to handle an additional sixty cubic feet per minute of exhaust per smoking lounge occupant, and for the supply system to provide a compensating amount of make-up air. If capacity is sufficient, location of smoking lounges in the vicinity of an existing exhaust point will minimize the installation costs.

Opportunities in Major Renovations and New Designs

Where major renovation work or new design allows, high-rise buildings offer an excellent opportunity for the installation of new technologies that provide convenient accommodation for smokers and non-smokers. The high degree of environmental control implicit in high-rise design makes installation of special features potentially cost effective options, such as wall-less smoking areas that isolate smoke using air pressure, or use of displacement ventilation, floor plenum air supply, or personal environmental control modules. While these improvements require an initial capital investment, the net gain in the quality of the indoor environment, and the net efficiency improvements in building performance may outweigh the costs.

Developing a cost effective approach to good indoor environmental quality in a high-rise building requires a high degree of cooperation among owner, manager, and occupants, and collaboration with the designer, as can be seen in the example of accommodating smokers. The determination of occupancy levels for smoking areas or lounges presents a key aspect in calculating ventilation and filtration requirements for the designer. Yet, the occupant loading factors can only be determined in cooperation with the tenants, whose smoking policy may influence requirements. A policy based on smoking lounges and pre-established group smoking break times may seem simple to the occupants, but it results in the maximum number of occupants in smoking lounges during very concentrated periods of time. On the other hand a staggered schedule of smoking breaks, or an open policy, reduces the probable number of occupants of the smoking lounge to a more manageable number. When large populations, such as those found in a high-rise, are the basis for design, open policies for smoking lounge use represent the most cost effective and convenient method of planning for both occupants and designers.

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Strategies for Accommodating Smokers

Mid-Rise Buildings

Mid-rise office buildings represent a substantial and growing portion of the office workspaces of today and the future. These buildings frequently offer the amenities of a high rise facility, with restaurants, shops, and other benefits that higher density use can afford. At the same time, they represent very diverse designs and engineering challenges. For example, HVAC systems for mid-rise buildings range from relatively simple ceiling plenum, passive return and exhaust systems to sophisticated powered variable volume supply and exhaust designs. The diversity makes each building an individual challenge in developing an approach to achieving good indoor environmental quality.

The diversity of uses and the relatively compact design of mid-rise buildings offer some advantages in the development of programs to accommodate both smokers and non-smokers in the indoor environment. The tenant-oriented design of many mid-rise buildings, which often results in HVAC system zoning based on tenant layout, provides an opportunity for each tenant to determine their own smoking policy. In addition, since many mid-rise structures incorporate cafeterias and other services with special ventilation needs, such as dry cleaners, HVAC systems frequently include the flexibility to add exhaust ventilation to specific areas. This flexibility makes it easier to develop designated smoking areas and lounges for the general use of the building occupants.

The supply of office space in mid-rise buildings grew dramatically throughout the 1980s, resulting in a highly competitive market for such space during this decade. Competition for leasing mid-rise space has grown so intense in most major US metropolitan areas that building owners and managers must use quality features, as well as price, to retain tenants and win new ones. A substantial part of the everyday effort to provide a quality facility focuses on traditional "sprucing-up" of the building appearance, with new carpeting, paint, wallpaper, and signage. But the tenant's agent of the 1990s and the future will look for a broader range of fundamental quality indicators. For some large corporations, it is already routine to do a preliminary environmental assessment of potential leased space. Sufficient accommodation for smokers and non-smokers will likely become part of the new tenant's list of features as they seek better indoor environmental quality.

A Tenant-based Approach for Accommodation

Flexibility in meeting the needs of individual tenant organizations is a primary requirement for leasing in most mid-rise buildings. Tenants range from small businesses to large, from suites of less than one thousand square feet to multiple floors. From computer rooms to break rooms, many of the spaces specified in a tenant's plan for office space may require special consideration to achieve indoor environmental quality.

Amid such diversity, accommodating a tenant's smoking policy becomes an important opportunity. For many tenants, allowing smoking anywhere in their space may be desirable, or they may elect to set aside specific smoking and non-smoking areas within their space. Tenants in smaller spaces, where setting up separate smoking areas may not be feasible, often prefer the building to provide a central smoking lounge to accommodate employees and guests who smoke. Buildings which incorporate restaurants or cafeterias also need to evaluate how to accommodate the needs of smokers and non-smokers in these public places.

Engineering Solutions

For new designs, with ventilation rates based on ASHRAE Standard 62-1989, ventilation should be sufficient to allow smoking in tenants' space. However, for older buildings designed with lower ventilation rates than suggested in the 1989 Standard, design options include increased ventilation with outdoor air or improved filtration, combined with improved useplanning. By developing a detailed useplan with the tenant, the wide range of indoor environmental issues can be integrated into an effective zoning and ventilation plan that supports specific uses, including smoking areas. The zoning plan may specify added outdoor air or filtration, and possibly localized exhaust, to achieve the best possible balance for the indoor environment within the tenant's budget.

Buildings which elect to develop a central smoking area or lounge stand to gain a distinct competitive advantage, provided the facility is well designed and operated. For new construction, design options abound, including such cutting edge approaches as displacement ventilation and wall-less pressure zones for smoking lounges. For retrofit

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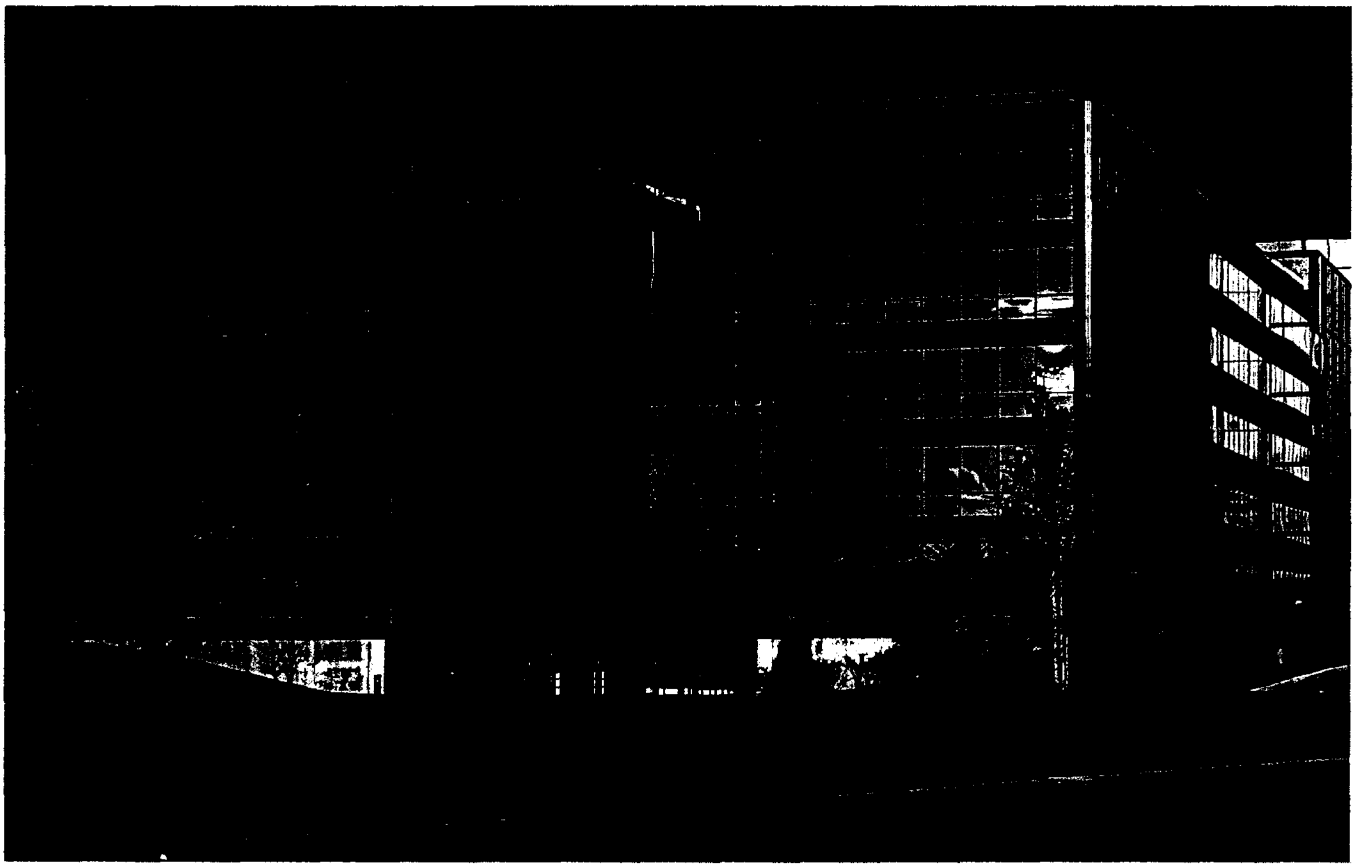

▲ *Mid-rise office buildings can improve their competitive position by accommodating tenant smoking policies and other diverse uses tenants require from their facilities today.*

applications, where an existing restaurant or cafeteria already requires specific exhaust systems, locating a central smoking lounge or area in the vicinity of the eating area will reduce the complexity and cost of including the smoking lounge. Within eating areas, designated smoking areas can be managed by use of careful zoning and pressure relationships.

By designing in central accommodation of smokers, building owners and managers in mid-rise buildings can offer tenants the widest range of accommodation solutions for their convenience. And the accommodation approaches available provide the maximum benefit to indoor environmental quality.

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Strategies for Accommodating Smokers

Small Office Buildings

The fastest growing portion of the commercial office space market in many parts of the U.S. today is the single story office park. Ranging from single buildings to dozens of acres of facilities, and often mixing office and light industrial or warehouse functions, these widely dispersed workplaces now play an important role in housing the American worker. With relatively simple structural and mechanical designs, their popularity has grown for many reasons: great flexibility for multipurpose use, convenient locations for highway transportation, and relatively low capital and leasing costs. Small and mid-size businesses, employers of the majority of the US workforce, use the "build-to-suit" option for this type of space to accommodate their specific needs.

The challenges for managing indoor environmental quality in these facilities often derive from the same design features that make them so popular. Factors such as comfort, air quality, ergonomics, and ambiance often take a distant backseat to utility, structural capacity, security, and low initial construction cost. Several typical design features generally contribute to the environmental challenges: small rooftop ventilation systems, small bathrooms and kitchens scattered throughout the space, minimal separation of industrial or warehouse support systems from office areas, floors and walls with high thermal gradients. The single most significant advantage for managing these indoor environments comes from the flexibility inherent in the ventilation system, and the ease with which changes in ventilation can be made.

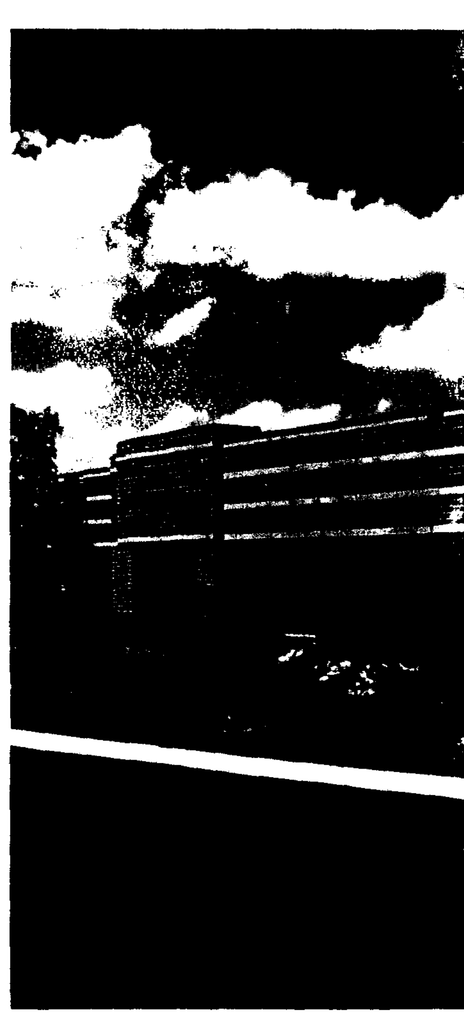
The accommodation of smokers and non-smokers in single story office facilities has generally been approached as a policy issue, either allowing or banning smoking. Where smoking is restricted in occupant office space, smokers generally resort to the industrial or warehouse space, common areas of the building (where they exist), or the outdoors. But the design features of single story office spaces make them excellent candidates for establishing smoking areas and lounges, or even accommodating individual smokers. And, as part of designing or retrofitting properly zoned and balanced HVAC systems, the additional capital and operating costs prove minimal.

Small System Environmental Design Characteristics

The quality of the indoor environment in single story office buildings often rests primarily on the design and operational parameters of the ventilation system. While the many other factors that contribute to good indoor environmental quality are no less important in this setting, the spartan nature of the buildings and the limits of their simple design and construction techniques reduce the concept of quality to its most fundamental elements. Ventilation is the primary element of concern because it is also the most frequent source of quality complaints in this type of building. For all of the simplicity and flexibility of this style of design, single story office buildings often lack sufficient supply of outdoor air, and sometimes transport contaminants from one part of the building to another through poorly zoned HVAC systems. Perhaps because of the simplicity of these buildings, ventilation design sometimes receives insufficient attention.

Designing ventilation systems to achieve good indoor environmental quality in small office buildings follows certain basics:

- Supply sufficient outdoor air
- Separate tenants and space use with ventilation zones



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- Provide localized exhaust to remove airborne substances at or near their sources

Within this context, space use planning can readily incorporate accommodation of smokers, an enhancement to indoor environmental quality likely to be important to many tenants of this type of building. For tenants electing to allow smoking throughout their facility, designing ventilation to supply sufficient outdoor air to meet the guidelines of ASHRAE 62-1989 should suffice. For tenants wishing to provide separate smoking and nonsmoking areas, use of pressure balance techniques and localized exhaust for smoking areas will enhance the environment. For larger tenants seeking a smoking lounge option, the slab floor and direct access to potential roof exhaust place no limitations on the design.

Typical design for single story office ventilation uses air handling units with passive return/exhaust, relying on exfiltration and kitchen and restroom exhaust to release outdoor air introduced through the fan system. The effect is to create a positive pressure on the building, which is as it should be, with small negative pressure zones around kitchen and restroom areas. Small kitchens and restrooms are typically incorporated into each tenant's space. The simplest and lowest cost approach to adding a smoking area or lounge is to increase the exhaust in the vicinity of these facilities to create an additional area of relative negative air pressure, isolating and exhausting tobacco smoke. These facilities are sometimes improperly exhausted into the ceiling plenum, rather than directly to the outdoors. Before implementing a smoking area or lounge that uses existing exhaust, check to be certain that the exhaust system vents to the outdoors.

Spring Lake Business Park, Itasca, Illinois—developed by Amli Realty Co.

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Source: https://www.industrydocuments.ucsf.edu/docs/qkkn0000

Technology Options

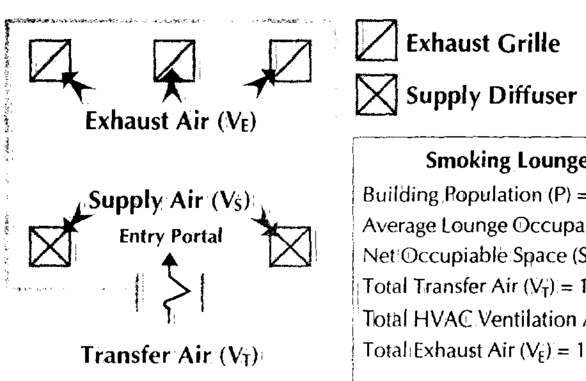
Impact of Standards

Indoor environmental quality is the sum of deliberate and accidental events in the design, construction, operation, and use of a building. A building represents a created environment, which is to say it comes into existence only by our deliberate action. As such, the indoor environment is in large part a function of the technology available for its construction and operation.

Technology issues abound in the design, construction, operation, and use of buildings. For example, as electronic control technologies continue to expand their reach into building design and operation, the role of the building engineer continues to change. Electronic monitoring has replaced many of the daily inspection rounds typical of building engineering and maintenance twenty or thirty years ago. For the indoor environment, that translates into more consistent control, but greater risk that some undetected event, like accumulation of water in a drain pan that gradually promotes growth of microorganisms, might produce contamination of the ventilation system. Higher and higher degrees of monitoring and control race to keep pace with opportunities to protect and enhance the indoor environment. In turn, codes and standards face the challenge of keeping pace with changes in building technology and use.

Beginning with a multi-dimensional useplan for a building, a designer is confronted with selection of the appropriate technologies for structural, mechanical, electrical, and related systems that can produce a high quality indoor environment within the project budget. The interactive process of useplanning, design, specification, budgeting, and redesign requires constant attention to the tenets of value engineering to meet the goal of affordable quality. A key part of this process is the evaluation of the technological options available, and the codes and standards that encourage or limit technology choices. Looking to the technology for accommodating smokers, which ranges from tried and true designs to innovative and creative solutions, a model emerges for evaluation of good management practice to achieve indoor environmental quality.

Simple Smoking Lounge Configuration



Smoking Lounge Example

Building Population (P) = 1,000 people
Average Lounge Occupancy (P_O) = 33 people
Net Occupiable Space (S_L) = 472 sq ft.
Total Transfer Air (V_T) = 1050 cfm
Total HVAC Ventilation Air (V_S) = 930 cfm
Total Exhaust Air (V_E) = 1980 cfm

Fig. 4

Codes and Standards

The operative national standard for ventilation, ASHRAE Standard 62-1989, provides a starting point for the evaluation of approaches for attaining adequate ventilation, while at the same time accommodating smokers and non-smokers in the indoor environment. Note that local codes and ordinances may have requirements more or less stringent than the ASHRAE Standard, and should be consulted for design guidance.

The accommodation of smoking and non-smoking has been a long-standing issue for the ASHRAE ventilation standard. In its original iteration ASHRAE Standard 62-73, *Standard for Natural and Mechanical Ventilation*, which is still referenced in many local codes, set minimum and recommended levels of ventilation. Under the influence of energy conservation goals and questions about minimum ventilation rates, review and revisions resulted in ASHRAE Standard 62-1981, *Ventilation for Acceptable Indoor Air Quality*, which set separate ventilation rates for smoking and non-smoking areas. Confusion resulting from the differentiation of smoking and non-smoking areas led to the revisions incorporated into the current version,

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Calculating Ventilation Rates for Smoking Lounges Under ASHRAE Standard 62-1989

Smoking lounges are treated as a special case under ASHRAE Standard 62-1989. The Standard calls for higher ventilation rates for smoking lounges, but allows use of "transfer air," which is air drawn directly from other parts of occupied space. Here are the steps necessary to translate the ASHRAE Standard into a practical smoking lounge design.

1. Calculate the average occupancy (P_O). First, establish how many smokers populate (P_S) the area served by the lounge. This can best be done through a survey. If that is impractical, a rough estimate can be obtained by using the population average, 26%, applied to the building population (P). Second, establish the peak usage population to set the maximum occupancy (P_M) of the lounge from survey data, or for approximation, assume that 25% of the smokers will use the lounge at any one time around lunch hour. Third, calculate the average number of occupants in the lounge (P_O). Average occupancy must be greater than one half of maximum occupancy, in accordance with the ASHRAE Standard as it applies to areas of intermittent or variable occupancy. Here's an example that uses rough approximations:

   P = 1000 people
   $P_S = P * 26\% = 260$ smokers
   $P_M = P_S * 25\% = 65$ maximum number of smoking lounge occupants
   $P_O > (P_M/2) > 65/2 > 32.5 = 33$ average number of smoking lounge occupants

2. Calculate the minimum floor area of the lounge (S_L). Use the average occupancy of the lounge (P_O) multiplied by the number of square feet per occupant (S_O) established in the ASHRAE estimated maximum occupancy to determine the minimum net occupiable space required for the smoking lounge. For example:

   $S_O = 1000$ sq ft / 70 maximum number of occupants = 14.29 sq ft per occupant
   $S_L = P_O * S_O = 33$ occupants * 14.29 sq ft = 472 sq ft net occupiable space

3. Calculate the minimum ventilation rate for the lounge (V_E). Multiply the average occupancy (P_O) of the smoking lounge by the outdoor air requirements (V_O) set for smoking lounges in ASHRAE 62-1989 to determine the minimum ventilation rate, here shown in cubic feet per minute (cfm) per person. The minimum ventilation rate equals the amount of air that must be removed from the lounge, and generally should be exhausted directly to outside. Hence the minimum ventilation rate for this calculation is assumed to be the same as the exhaust rate (V_E). For example:

   $V_E = P_O * V_O = 33$ occupants * 60 cfm = 1980 cubic feet per minute

4. Calculate the transfer air available for ventilation (V_T). For a simple smoking lounge, leaving the access to the room as an open portal rather than installing a door allows for both supply of transfer air and an effective air curtain to avoid the spread of smoke outside of the lounge. If the entrance wall is fire rated, a closable door will be necessary. In that case, use a transfer grille fitted with smoke or fire dampers as required. Using the open portal access, and assuming the transfer air is of sufficient quality, the calculation of transfer air is the product of two variables that are physical aspects of the design: the size of the entrance way (S_F), and the velocity of air (V_V) required for the air curtain effect. For reference, most people can sense air movement over 70 feet per minute, and laboratory hoods require a face velocity of 60 to 100 feet per minute. For example, using an air velocity lower than normally sensible:

   $V_T = S_F * V_V = (3 \text{ ft} * 7 \text{ ft}) * 50$ feet per minute = 1050 cfm transfer air

5. Calculate the minimum supply air required for ventilation (V_S). The total supply air required will be determined by desired space temperature, internal heat gain, solar gain, transmission losses and related factors. Because of the high ventilation requirements for smoking lounges, and the high rate of transfer air assumed here, a simplified formula can suffice for this example. The ventilation air required to be delivered from the HVAC system to the smoking lounge is the remainder of the total exhaust air (V_E) less the transfer air (V_T) that enters through the entrance way to the lounge. For example:

   $V_S = V_E - V_T = 1980$ cfm - 1050 cfm = 930 cfm supply ventilation air

Fig. 5

ANSI/ASHRAE Standard 62-1989, including Addendum 62a-1990.

The current version of the ASHRAE Standard simplifies the question of accommodation of smoking and non-smoking in the indoor environment through two basic mechanisms:

- Using the "Ventilation Rate Procedure" for design, ASHRAE Standard 62-1989 provides ventilation rates for generally occupied areas where moderate levels of smoking are expected, and specific ventilation rates for smoking lounges.
- Using the "Indoor Air Quality Procedure" for calculation, ASHRAE Standard 62-1989 provides for measurement of specific contaminants and subjective evaluation of the sufficiency of ventilation rates for adequate control of indoor air contaminants, including environmental tobacco smoke.

If a building owner or occupants elect to allow smoking throughout their facilities, the basic "Ventilation Rate Procedure" of Standard 62-1989 suggests outdoor air requirements that may be expected to produce acceptable indoor air quality. Similarly, should specific design challenges, such as restricted access to good quality outdoor air, set limits on available outdoor air, the "Indoor Air Quality Procedure" offers an alternate method for determining ventilation rates to satisfy occupants' perceptions of indoor air quality. Several other features of ASHRAE Standard 62-1989 afford selection of options for the advancement of technologies to accommodate smokers and non-smokers, such as the option to filter recirculated air as a substitute for outdoor air, and the consideration of plug flow (or displacement) ventilation techniques for increased ventilation effectiveness.

The effect of ASHRAE Standard 62-1989 requirements for ventilation is to set a floor for ventilation levels, and to encourage innovation in design to meet the specific needs of building occupants while permitting the accommodation of both smokers and non-smokers. The next few pages explore the basics and the innovations that can be used in this context.

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Source: https://www.industrydocuments.ucsf.edu/docs/qkim0000

Technology Options

Displacement Ventilation

One specific option within ASHRAE Standard 62-1989 for controlling specific types of contamination in indoor environments is called plug flow ventilation, now often referred to as displacement ventilation. The concept is elegant in its simplicity: air is introduced at or near floor level and uses the thermal gradient across the vertical plane of the room to create an upward airflow, which is then exhausted through ceiling grilles, removing any contaminants that may have been introduced in the room. Since the early 1980s, this technology has been demonstrated extensively in Northern Europe, where the cool, low humidity climate makes the plug flow concept an excellent choice for energy efficiency. For smoking lounges, displacement ventilation offers the potential for rapid removal of environmental tobacco smoke with minimal mixing in the space.

Important development efforts and demonstrations of displacement ventilation technology show how flexible and widely applicable the plug flow approach can be. Designs based on diffusers at floor level and systems using elevated flooring are being tested around the world. All of these designs offer the potential for improved energy efficiency, while raised floor designs add the possibility of integration of air supply and utility corridors for electrical and communications systems, and improved indoor air quality.

Displacement Ventilation Design Basics

Displacement ventilation systems begin with the introduction of air that is slightly cooler than mean room temperature at or near floor level. Demonstrations of the technology show that a temperature of 66° F to 68° F produces the desired thermal effect, while avoiding drafts and cold ankles for occupants. The air must be introduced at low velocity to minimize mixing near the floor area of the space. This is done by creating a large supply plenum with low pressure, rather than the traditional high pressure diffusers that stimulate turbulence. The flow in a displacement system derives from the buoyancy forces, which spread the supply air in a thin layer at the floor of the room. Heat sources within the space, such as occupants or office equipment, then generate plumes, drawing the supply air up and past them, lofting it toward the ceiling, where it is exhausted.

The radiant surfaces of the ceiling, floor, and walls all create complications for the design of displacement ventilation systems. The combined effects of the radiant behavior of the floor and ceiling and the thermal gradient across the vertical plane cause the floor to be slightly warmer than the air introduced by the system, while the ceiling is slightly cooler than the air being exhausted. Walls also represent radiant heat sources, and vary in thermal character with the seasons. These may create turbulence which effectively draws needed ventilation air away from occupied areas. Perimeter heating and cooling devices can be useful in overcoming this characteristic, particularly for exterior walls. Proper design parameters for the thermal gradients are

**Displacement Ventilation
Smoking Lounge Schematic**

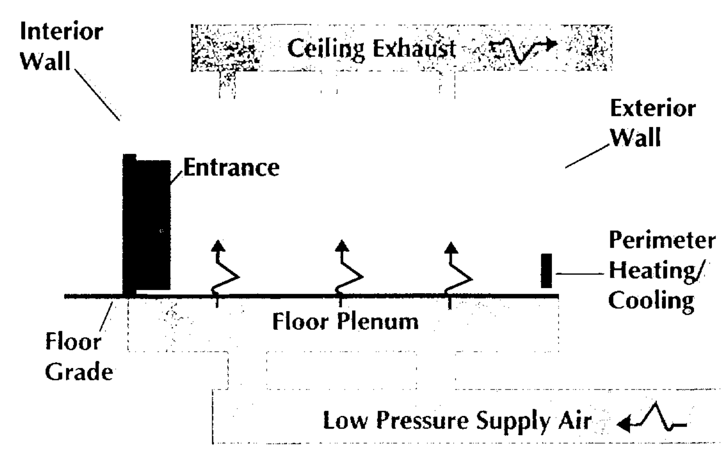

Fig. 6

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Source: https://www.industrydocuments.ucsf.edu/docs/qklm0000

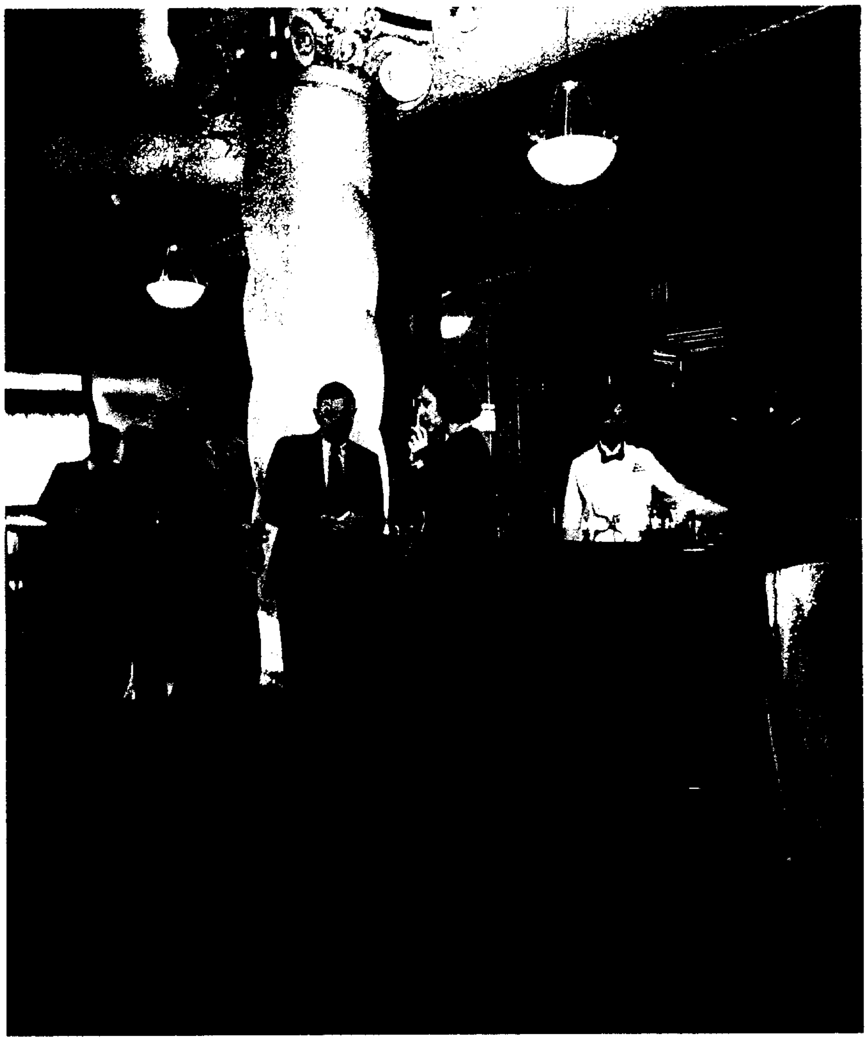
critical to avoid thermal and contaminant stratification that might affect comfort and air quality in the breathing zone.

Smoking Lounge Applications

The logic of using displacement ventilation for smoking lounges comes from the effectiveness of the thermal plume generated by the smoker, creating an upward flow of air that sweeps environmental tobacco smoke up and away from room occupants into the ceiling area, where it is exhausted. The low velocities of the displacement ventilation approach provide a comfortable, draft-free environment without sacrificing contaminant removal efficiencies.

Floor level diffuser technology has proven effective in office and factory applications in Northern Europe. Elevated floor techniques have been demonstrated in practice for more than two years at one of the premier arts centers in the U.S., the Benedum Center in Pittsburgh, accommodating smokers in a non-smoking building. Designed to accommodate 100 smokers, the lounge supplies a minimum of 6,000 cfm of outdoor and treated, recirculated air through the floor of the room. The floor plenum, a computer floor covered with permeable carpeting, serves as a low velocity diffuser for the entire area. Six ceiling mounted exhaust/return grilles remove the warm air and tobacco smoke.

Displacement ventilation technology presents a great opportunity in the context of new building designs and major retrofit programs. All of the components of the displacement design are, in themselves, conventional. The principal challenge is designing the space to incorporate a low velocity terminal device in or near the floor. Experienced vendors from Europe now offer their systems in the U.S. With the concept proven in projects in both North America and Europe, the remainder of the challenge is establishing operating parameters that integrate ordinary HVAC equipment into an effective plug flow design.



▲ *The Benedum Performing Arts Center in Pittsburgh uses displacement ventilation technology to accommodate smokers in this convenient and comfortable lounge.*

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a self-contained smoking lounge ventilation system incorporating energy recovery could prove cost effective, while simplifying design parameters.

Air Filtration Technology

A variety of particle and gas phase filtration systems have entered the market to respond to special needs of some industries, and the growing general interest in indoor environmental quality. The specialized needs of laboratories, computer clean rooms, and manufacturing processes have spawned high efficiency particulate removal devices, ranging from fiberglass HEPA filters to electrostatic precipitators, as well as electrically and chemically active devices using negative particle charges, neutralization charges, ozone generators and a variety of activated carbon-based filters. The creativity of filtration device manufacturers has rapidly outstripped the standard-setting process at ASHRAE, leaving a gap in the methodology for evaluation of the effectiveness of filtration devices based on manufacturers statistics. Evaluating filters for treatment of return air from smoking lounges provides a sample of the opportunities this technological change may bring.

Current practice in ventilation system management provides experience with two basic options in advanced filtration: electrical field manipulation of contaminants, and use of chemical adsorbents in the context of fabric filters. Several variations on electrical cleaning are available commercially. Standard electrostatic precipitators have not generally proven effective in removing odors that are associated with tobacco smoke. Variations on precipitators that use electrical charges to agglomerate vapors and small particles for removal in conventional filters have anecdotal support in smoking applications. Similarly, activated carbon beds used with prefilters and medium to high efficiency filters downstream have proven effective for odor removal in smoking lounges, such as the one at the Benedum Center in Pittsburgh.

Occupancy Based Control for Smoking Lounge VAV Application

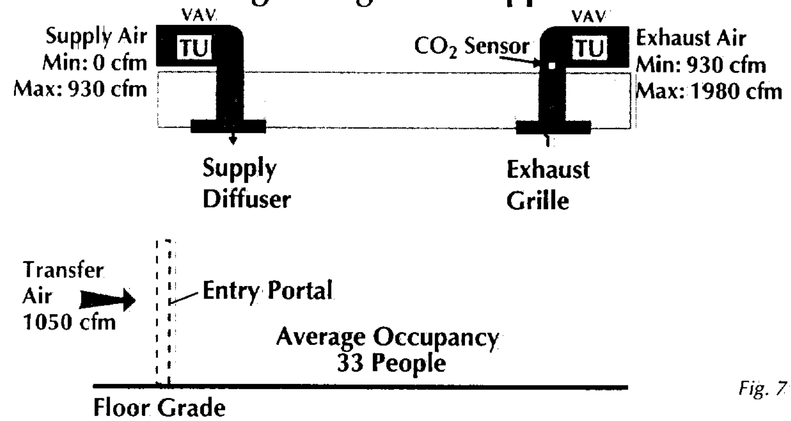

Fig. 7

Advanced Carbon Bed Filtration System

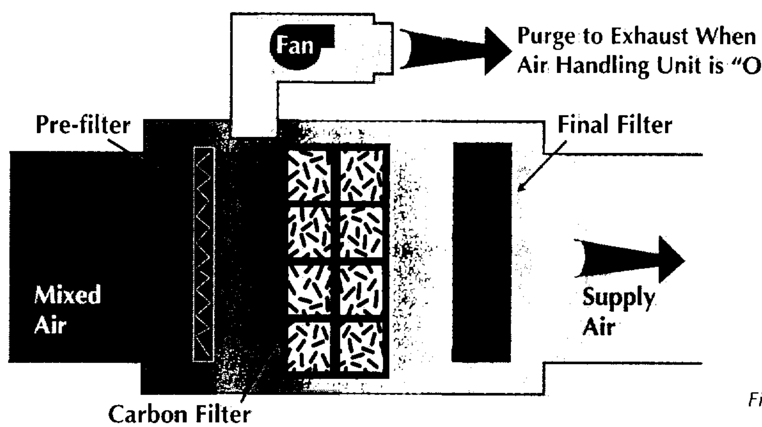

Fig. 8

"Run-around Loop" Heat Recovery

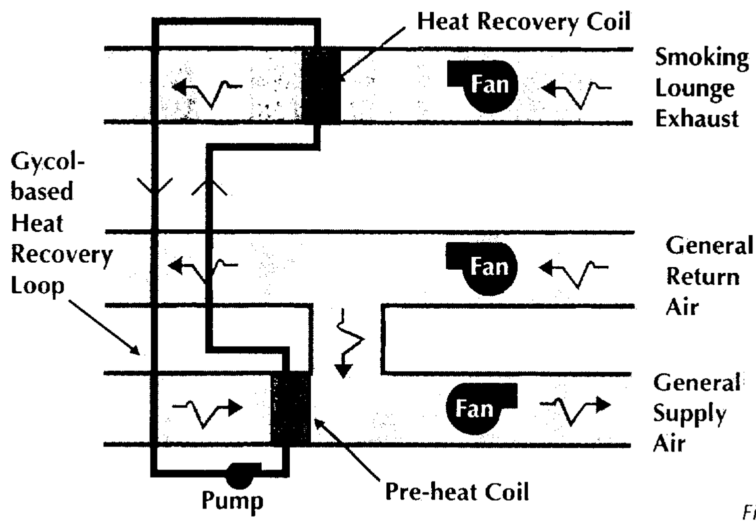

Fig. 9

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Technology Options

Energy Savings Systems

Indoor environmental quality and energy efficient operations can be compatible goals when pursued simultaneously in the design of new or extensively retrofit space. The ventilation rates recommended in ASHRAE Standard 62-1989 represent a significant increase in recommended levels of outdoor air from previous iterations—offices, for example, jumped from five cfm (cubic feet per minute) of outdoor air to twenty cfm per occupant. Several existing and emerging technologies offer ways to counter the increased energy use that this change in ventilation rates implies.

Designing a smoking lounge presents an even more interesting opportunity to integrate environmental quality and energy efficiency goals. ASHRAE recommends ventilation rates of 60 cfm per occupant for smoking lounges. The first energy efficiency opportunity derives from the ability to use transfer air to ventilate the smoking lounge. The transfer air, used in the smoking lounge and exhausted to the outdoors, represents a portion of the exhaust air needed to relieve the ventilation air introduced to adjacent spaces. Several other basic technical options are available:

- Automated control to reduce ventilation levels at lower occupancies
- Heat exchange devices for recovering latent energy in the exhaust
- Advanced filtration devices for full or partial recirculation of air removed from the lounge

Automated Control Options

Electronic direct digital control (DDC) of building mechanical systems has grown in sophistication as it has improved in ease of use. As indoor air quality and related issues push to the forefront of building management, developers and manufacturers of control systems have responded with an array of new sensors and related software to automate the management of this aspect of building control. Two key types of sensors are presently available for integration into most DDC systems: carbon dioxide (CO_2) sensors that indicate human occupancy, and gas sensors that determine the presence and concentration of volatile organic compounds (VOCs). Sensors are typically mounted in return ducts, sending an electronic signal to be translated into a monitoring or control point for the automation system. In control applications, the sensors can be used for modulation of outdoor air control dampers, variable air volume (VAV) systems, or both.

In the context of smoking lounges, a CO_2 sensor offers an excellent first step in energy efficiency by allowing control of supply and exhaust. In the context of a VAV design, a CO_2 sensor could be used to determine smoking lounge ventilation requirements. In an unoccupied lounge, the exhaust would be set to maintain the transfer air entering the lounge, while supply air from the HVAC system could be reduced to zero. As occupants enter the space CO_2 levels increase, signaling the VAV system to increase both exhaust and tempered supply air. The minimum settings for transfer air preserve the quality of the environment in and around the lounge, while energy to satisfy occupant needs is expended in the lounge only as the occupants require it.

Energy Recovery Technology

Several technologies have proven effective for recovering energy from an HVAC system exhaust: air-to-air heat exchangers; liquid medium heat exchange run-around loops; and more recently desiccant heat wheels. Air to air heat exchangers provide moderate efficiencies, typically around 55% to 70%, for pre-heating or pre-cooling outdoor air as it is introduced into an air handler. Heat exchange run-around loops, typically filled with a glycol-based solution, fulfill the same function and provide roughly the same efficiency. Desiccant-based heat wheels offer the potential of recovering both the sensible (temperature) and latent (humidity) components of the exhaust stream energy for reuse, resulting in a higher efficiency compared to other technologies.

Energy recovery technology offers an option in the accommodation of smokers and non-smokers by reducing the efficiency penalty from increased ventilation rates. From the perspective of accommodating moderate smoking in all areas, the preconditioning of outdoor air afforded by energy recovery systems can compensate for much of the increased outdoor air ventilation specified in ASHRAE Standard 62-1989. Some studies suggest that the most efficient of these technologies can provide overall system performance at 20 cfm outdoor air per occupant equivalent to a conventional design at 5 cfm per occupant. The technology can also be applied to energy recovery from exhaust systems serving smoking lounges. With the higher ventilation rates for smoking lounges suggested in the ASHRAE Standard,

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Technology Options

Air Pressure Zones

The open floorplan of the modern office provides greater flexibility in layout and use over time, but presents challenges in achieving indoor environmental quality from several perspectives. One of the most challenging aspects of the open floor plan approach is the variety of uses such space might be called upon to support. Often single cubicles and small groupings of occupants are adjacent to equipment centers where printing and copying take place, or near conference areas, where white board markers are frequently used. These layouts accommodate work flow, but may produce varying ventilation requirements to overcome the heat and emissions generated by these diverse activities. Using balancing of the supply and return/exhaust systems for an open floorplan area provides a basis for zoning sections of the area for specific uses without building walls.

The scope of this opportunity for improving the indoor environment can be seen in the design of an open area to accommodate both smokers and non-smokers. Air generally flows from areas of higher air pressure to areas of lower air pressure, from positive pressure in the direction of negative pressure. Using this simple concept, areas set aside for non-smokers can be maintained at a slight relative positive air pressure, while areas set aside for smokers can be maintained at a slight negative relative air pressure. This will produce a slight air flow from the non-smoking area into the smoking area, keeping the air from the smoking area from mixing with that in the non-smoking area. Through thoughtful planning and carefully supervised and tested balancing of the HVAC system, the preferences of both smokers and non-smokers can be accommodated without any additional cost to building operations.

Air Pressure Zoning Basics

Use of air pressure to create specific zones within an open area requires a rethinking of normal ventilation design. Conventional ventilation systems are designed to maximize the mixing between the air that is introduced into the space and the air that is already there. This mixing is called ventilation effectiveness. In a large open area, the air introduced from the overhead air diffusers mixes thoroughly throughout the area. Slightly more air is supplied to the area than is exhausted to keep the area at a slightly positive air pressure relative to the building envelope and access points. In this context, the large open area described here represents a single, positive pressure zone.

Beginning from a carefully developed useplan, this large single zone can be subdivided into smaller areas where specific activities, such as smoking, may take place without affecting occupants in other areas. Once the boundaries between zones are defined in the useplan, the ventilation layout can be adjusted to accommodate smoking areas. Overall ventilation rates for all areas should be sufficient to meet ASHRAE 62-1989 guidelines. Within that context, ventilation should be sufficient to accommodate a moderate amount of smoking. Total air supply for the general use area (S_G) should be slightly greater than the return/exhaust from the general use area to create a slight positive pressure relative to smoking areas (S_S). The quantity of air removed from the smoking area (R_S) should be approximately ten percent greater than the amount of air supplied to it to create a slight negative pressure. The quantity of air removed from the general use areas (R_G) should be less than the amount supplied to those areas by an amount sufficient to compensate for the added removal rate from the smoking area, while leaving an overall positive pressure in the space.

For example:

$$R_S = 1.1 * S_S$$
$$R_G = (0.95 * S_G) + (S_S - R_S)$$
$$(S_G + S_S) > (R_G + R_S)$$

The result of the pressure differential between the smoking area and the general use area is to create an air pressure barrier between the two areas that prevents the air in the smoking area from mixing with the air in the general use area. The exact proportions of the pressure relationships between general and special use areas can be adjusted to accommodate the varying degrees of activity that come with different uses, with higher degrees of activity generally requiring higher pressure differentials. This approach brings the added benefit that smokers and non-smokers can be accommodated without measurably influencing the initial capital cost or operating efficiency of the building.

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Air Pressure Zoning Concept

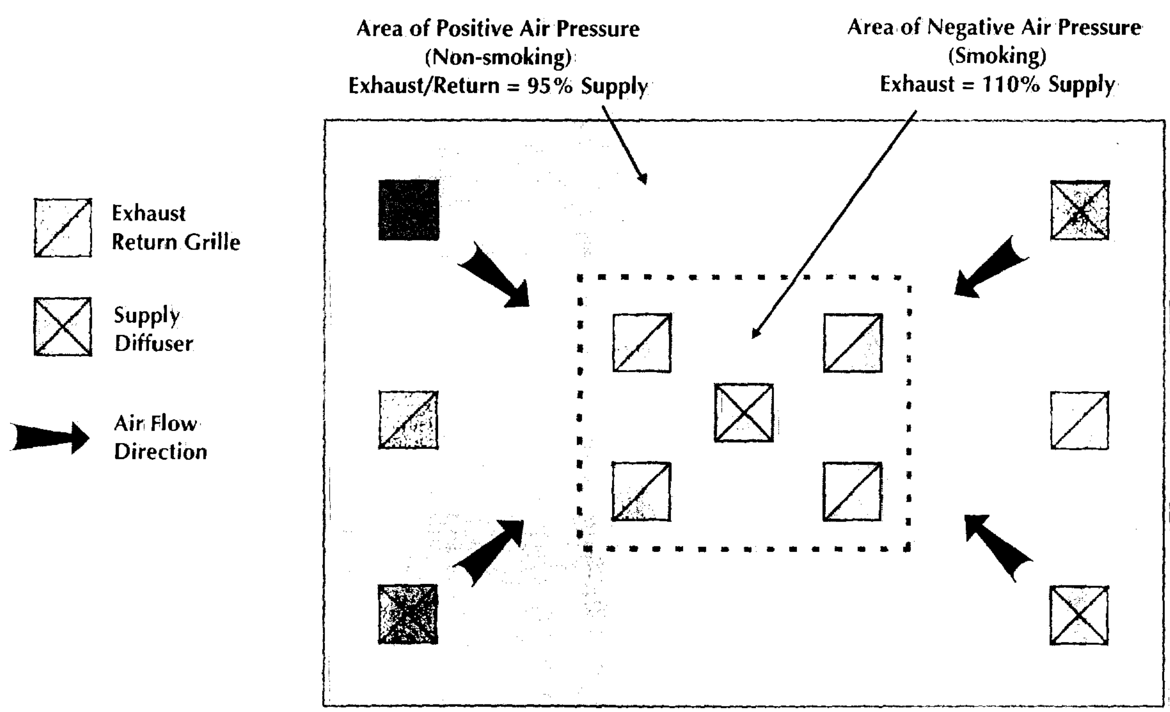

Fig. 10

▲ *The use of air pressure zones to create smoking areas is an especially useful technology option for reception areas, cafeterias, and restaurants.*

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Technology Options

Individual Smoking Areas

Several advances in technology make it possible to go beyond the designation of smoking lounges or smoking areas, and to allow individuals to choose whether they wish to have their own personal work environment as a smoking or non-smoking area. Allowing individuals this degree of choice presents an opportunity to reduce personal and organizational stress, while enhancing personal productivity.

Technical Options for Individual Smoking Areas

Several technologies allow individuals the choice of making their individual workspaces smoking or non-smoking. Whether the workspace is defined by a cubicle or an office wall, the key to this form of accommodation is to avoid mixing air from smoking and non-smoking areas. Three basic technical alternatives predominate:

- Filter the air in each workspace separately
- Pressurize each workspace using a local air supply
- Create a displacement (or plug flow) ventilation environment

Workspace filtration creates a local ventilation "bubble" in which an individual receives general ventilation air from central HVAC systems, then has a self-powered filtration unit which cleans and recirculates the air in their office or cubicle. For accommodation of smokers and non-smokers, filters must be capable of removing particulates and adsorbing vapors and gases. A combination pre-filter, activated carbon cell, and high efficiency particulate filter will accomplish this. Odors may occur as the carbon filters desorb when the units are off, or when carbon cells are not changed frequently enough.

Localized air supply to each workspace offers the option of ventilation and temperature control by the occupant. In most designs, low velocity air is supplied through a floor plenum, which allows flexibility in the location of ducting to individual workstations. A personal air diffuser and a control panel in each cubicle allow the occupant to control air flow. In some designs, air for corridors and other common areas comes from the "spill over" from the individual workstations. For systems to accommodate both smokers and non-smokers, common areas will need to be ventilated sufficiently to assure that any mixing of air from cubicles and common areas occurs only above the breathing zone.

Where an entire area is ventilated with displacement ventilation, the upward flow of ventilation air creates personal zones wherever a person is located. The person's presence creates a plume of ventilation air that brings supply air up from floor level and propels it into the exhaust zone. Total design based on displacement ventilation affords maximum flexibility in location of furnishings, as well as effective removal of not only tobacco smoke, but all airborne materials from the breathing zone of occupants.

Various Personal Filtration Units

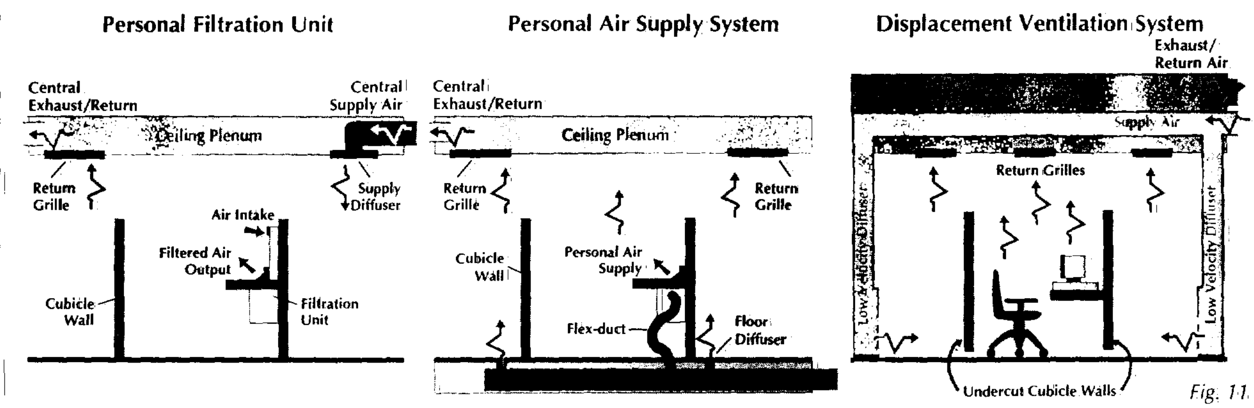

Fig. 11.

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Functional Design

Improving the indoor environment requires a complete, multi-dimensional useplan to take full benefit of investments in good engineering and new technology. Underlying the specific objectives of each building owner or tenant, the broad goals of improving productivity and minimizing personal and organizational stress enliven designs for indoor environmental quality. Each space within a well designed indoor environment should contribute to these goals.

In the context of designing smoking areas, particularly if a separate area or lounge is provided, the useplan should incorporate not only sufficient ventilation for its use, but practical features, such as desks and telephones, allowing smokers to remain productive throughout the day and minimizing personal and organizational stress. An individual using the lounge need not interrupt important work to smoke, which avoids the organizational perception that use of the smoking area is a "break."

Design Features for Functionality

Some of the options that should be considered in the useplanning process range from simple furniture selection to high-tech communications system integration. No detail should be overlooked. Furnishings should be oriented to the primary use of the area. For example, if the area is a smoking lounge, specifically designed for relatively brief use, a few tables and chairs for small group discussions can be combined with stand-up desks equipped with telephones, where a busy executive can set a notepad or portable computer and make a few phone calls. If the lounge is used by more than one tenant, support systems such as telephones can be provided on a credit card only or other custom billing basis.

Going beyond minimal accommodation, smoking areas can be designed with features such as special project areas, where smokers working on intensive projects can find temporary sanctuary and excellent working conditions. Providing a computer workstation or a port to data communications in the smoking area can dramatically enhance productivity. Small conference areas within the smoking area can also provide smokers and non-smokers with meeting and special project areas that help minimize organizational stresses. Once the basics of proper ventilation are achieved, creative useplanning opens a wide horizon for improving indoor environmental quality.

◄ *A well designed smoking area provides features for functionality, such as a convenient place for smokers and non-smokers to meet.*

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The Accommodation Model

The changes in the way people think about the buildings they occupy require designers to ask not what uses will be allowed, but how the many and varied uses can be accommodated. For each new building or major retrofit, the heart of this question for the designer rests in a carefully conceived and thoroughly tested multi-dimensional useplan.

The useplan grows from the project objectives set out by the building owner. Progressive layers of detail emerge as the overall shape of the building begins to conform with its purposes. From the shape of the exterior emerge the dimensions of the interior environment, not only in feet and inches but in light and air and sense of space. The dimensions of the interior space form the first lines of the patterns of use that will ultimately enliven and fill the building. Inch by inch, row by row, the many and varying uses of each measure of interior space define what structural and mechanical systems will be required, what life safety features, then what special features and support systems, what electrical and communications systems, what floor and wall coverings, furniture and lights. The useplan and the design intertwine as the idea of the building unfolds into drawings and models.

Interactive Planning

As the successive layers of design detail overlay the basic plans of the building, the useplan becomes the benchmark and the evaluation tool. The designer must set the design and the useplan side-by-side and approach them with a series of questions:

- Are both the useplan and the design consistent with the owner's objectives?
- For each planned use, have all applicable codes and standards been satisfied?
- Have the best choices of materials and equipment been made on the basis of value engineering?
- Does the design contribute to acceptable indoor environmental quality?
- Can the building be maintained over its lifetime to sustain both value engineering and environmental quality goals?

Evaluating Indoor Environmental Quality

Good design for indoor environmental quality produces a building that enhances productivity and minimizes the physical and psychological stressors on building occupants. A commitment to environmental design requires the same multi-disciplinary team approach typically applied to traditional engineering disciplines. To the mechanical, electrical, and structural evaluations must be added functionality, ergonomics, air quality, usability, maintainability, and aesthetics. To the analysis of cost effectiveness of equipment and material selections must be added consideration of product emissions and

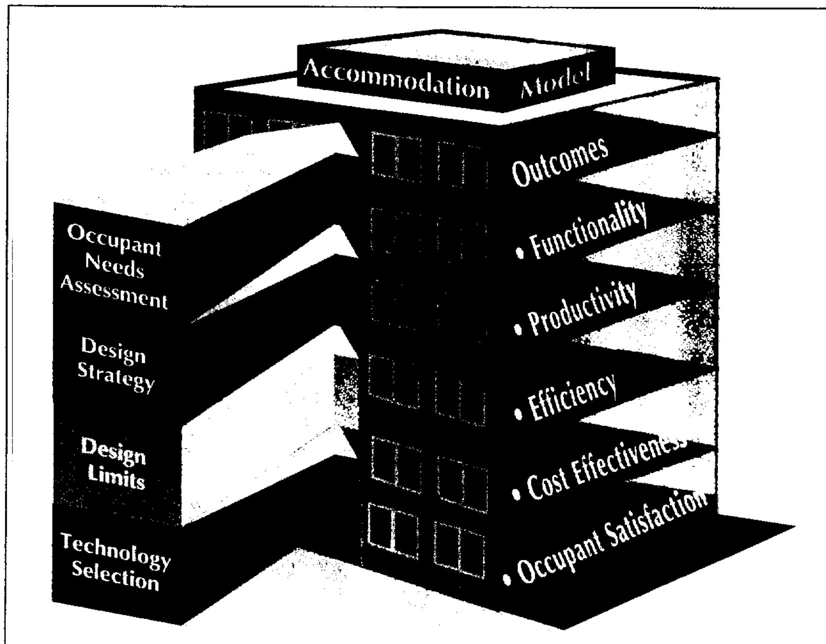

Fig. 12

◀ *A multi-dimensional useplan provides a basis for the accommodation model for achieving indoor environmental quality.*

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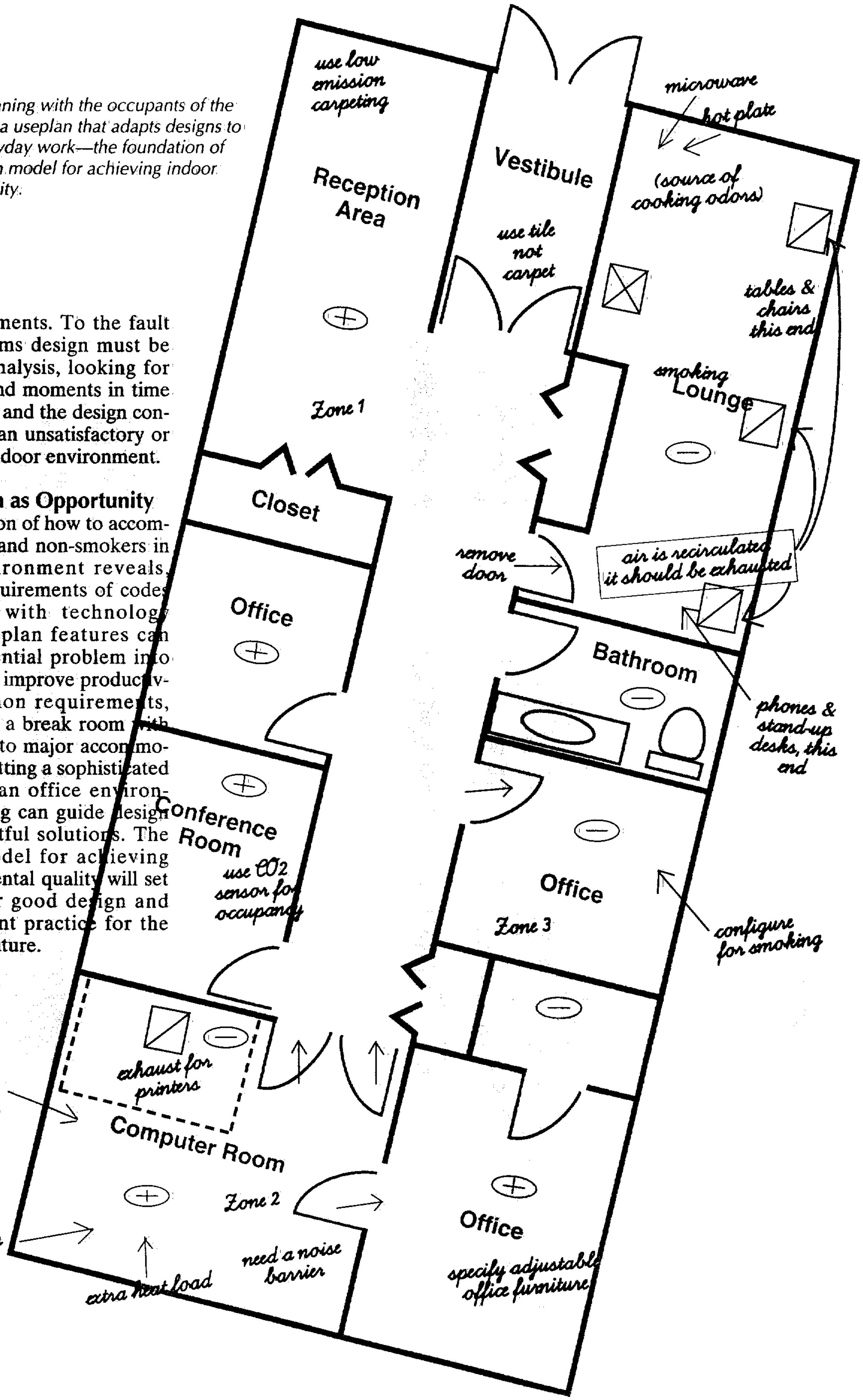
▶ *Cooperative planning with the occupants of the space can produce a useplan that adapts designs to the realities of everyday work—the foundation of the accommodation model for achieving indoor environmental quality.*

cleaning requirements. To the fault analysis of systems design must be added a stress analysis, looking for points in space and moments in time when the useplan and the design conflict, resulting in an unsatisfactory or non-productive indoor environment.

Accommodation as Opportunity

As the evaluation of how to accommodate smokers and non-smokers in the indoor environment reveals, matching the requirements of codes and standards with technology options and useplan features can transform a potential problem into an opportunity to improve productivity. From common requirements, such as providing a break room with kitchen facilities, to major accommodations, such as fitting a sophisticated print shop into an office environment, useplanning can guide design decisions to fruitful solutions. The useplanning model for achieving indoor environmental quality will set the standard for good design and good management practice for the buildings of the future.



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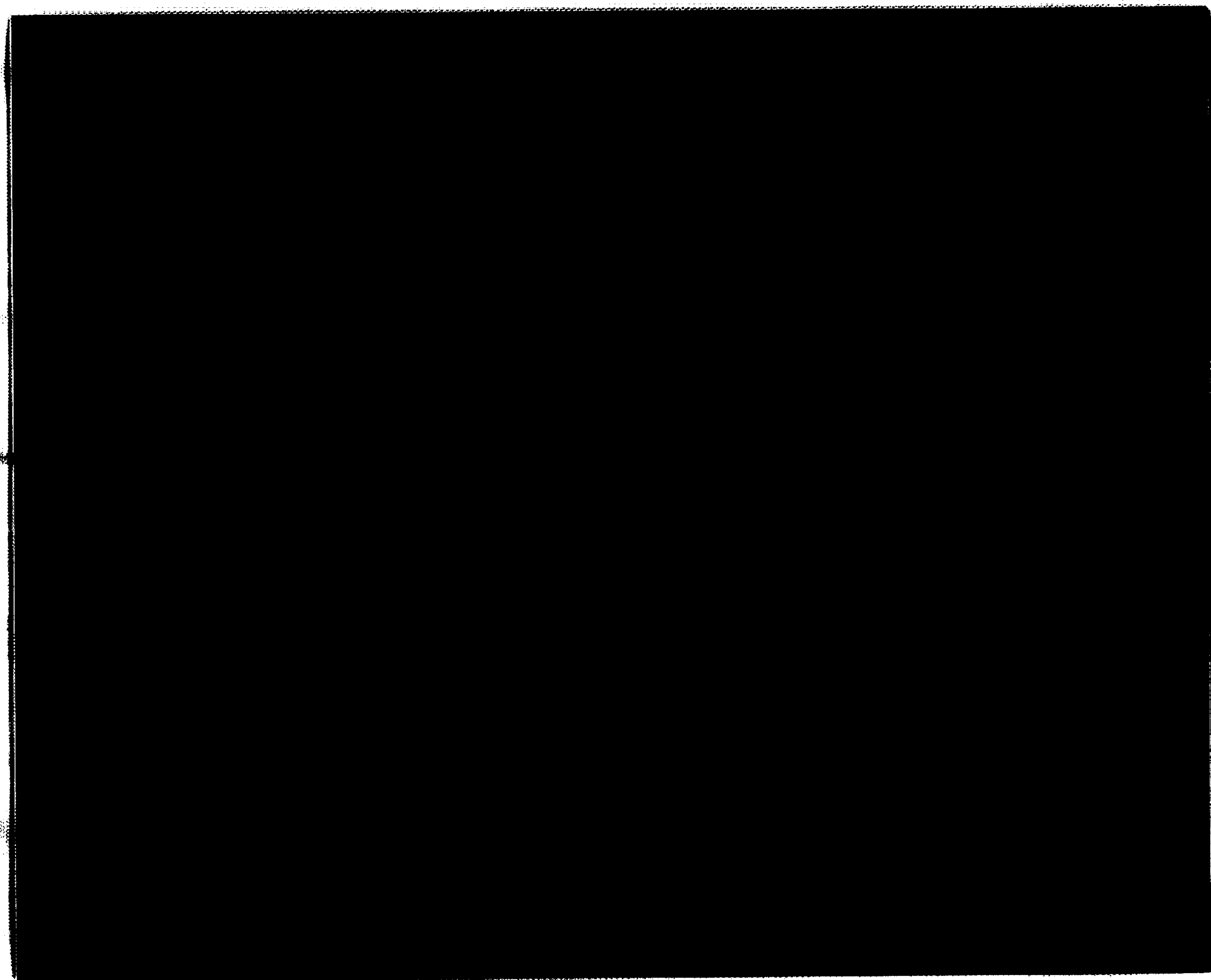

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LEGAL CONSIDERATIONS – EXECUTIVE SUMMARY

SMOKING IN THE WORKPLACE: THE CHOICE REMAINS

The Environmental Protection Agency's (EPA) report on environmental tobacco smoke (ETS) should not interfere with the employer's or building owner's efforts to accommodate smoking, even though the report's release and subsequent publicity have raised concerns.

EPA REPORT: SCIENCE OR POLITICS?

An expert panel of scientists convened by the EPA itself raised serious concerns about the EPA's "adjusting science to fit policy." The agency's report on ETS is an example of how justified that concern is.

EPA HAS NO STATUTORY AUTHORITY IN THE WORKPLACE

It is the Occupational Safety and Health Administration (OSHA), not the EPA, that has authority for the workplace and is currently studying the issue of air quality. OSHA has rejected previous requests to mandate smoking bans.

COURTS HAVE NOT BEEN SUPPORTIVE OF ETS CLAIMS

Legally binding decisions on workplace-related ETS claims under any legal theory have historically provided little support for workplace smoking bans. In all such claims, the claimant must prove that the injury was caused by exposure to ETS (not something else) <u>and</u> that the exposure was in the workplace (not in other places).

SMOKING BANS WILL NOT ELIMINATE INDOOR AIR QUALITY PROBLEMS

Visible accumulation of tobacco smoke is usually evidence of a more pervasive problem in today's modern buildings — inadequate ventilation. While a smoking ban will remove this visible marker from the air, it will not remove other constituents of indoor air, a build up of which can create a "sick" building and potential indoor air quality litigation.

ACCOMMODATING SMOKING IS AN EMPLOYER'S CHOICE

While some employees may find smoking objectionable, many employees do wish to smoke. Unless otherwise regulated, employers can choose to accommodate smoking.

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SMOKING IN THE WORKPLACE: THE CHOICE REMAINS

Being an employer in the 1990s is much more difficult than at any other time in history. As the workforce becomes more diverse, so do the issues facing employers. One of these issues is how to maintain a satisfied workforce whose race, gender, physical abilities and lifestyle choices range from one end of the spectrum to the other.

One of those lifestyle choices is smoking. Some people are smokers and others are not. For many years, employers have accommodated smoking and non-smoking employees without problem by establishing a smoking policy that addresses the concerns of both. Most employers understand that reasonable accommodation is a good foundation. Unless otherwise regulated, employers can choose to accommodate smoking.

However, a report released on January 7, 1993 and subsequently publicized by the U.S. Environmental Protection Agency (EPA) has raised concerns among employers and building owners about their continued ability to accommodate the desires of both smoking and non-smoking employees. The report states that Environmental Tobacco Smoke (ETS) should be classified as a Group A carcinogen, in other words "known to cause cancer in humans."

In light of the decision, many employers and building owners are asking what it means to them.

The quick answer is, *nothing about this decision [EPA's report] in a legal or regulatory sense should interfere with an employer's or building owner's right to accommodate both smoking and non-smoking employees and/or tenants in the workplace.*

Nonetheless, given the EPA publicity regarding the report, the two questions still most frequently asked by employers/building owners are:

1. **Is there any regulatory requirement resulting from the EPA's report that would require employers to ban smoking in the workplace?**

   The answer is **no.**

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2. **Does the EPA's report mean there is increased liability for the employer who does not ban smoking?**

Once again, the answer is **no**.

Any employer or building owner considering a smoking policy or a change in present policy, who has a question concerning indoor smoking, should consult legal counsel and a human resources director. All decisions should be in compliance with applicable local laws and any applicable collective bargaining agreements.

Apart from any legal consideration, employers should already be addressing concerns related to the comfort and well-being of their employees. Reasonable policies of accommodation and proper attention to overall indoor air quality are basic to a productive, satisfied workforce.

EPA REPORT: SCIENCE OR POLITICS?

> "The EPA's recent findings, and its declaration that second-hand smoke is a class A carcinogen does not, per se, place a new liability on employers which did not exist before."[1]

Because the scientific claims made by the EPA are based on previously published material that has been manipulated to fit EPA's predetermined positions on smoking, the report should have no more judicial significance than the reports issued in the mid-1980s by the Surgeon General and the National Academy of Sciences that were based on many of the same studies.

1 Letter dated March 22, 1993, to Rep. Phyllis Kahn, signed by John R. Tunheim, Chief Deputy, Office of the Attorney General, State of Minnesota.

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In addition, *the relevance of the EPA report to the workplace is questionable* because:

- the selected data sets were only of married women — non-smokers married to smokers;
- the data sets were from reported home exposure — not workplace exposure;
- the selected data sets for determining exposure to ETS were derived from questionnaires — not measured exposures;
- serious questions about the strength and validity of EPA's conclusions remain, including:
  - EPA's deviation from generally accepted scientific and statistical procedures for risk assessment;
  - EPA's failure to follow its own published guidelines, risk assessment and exposure assessment;
  - recent published scientific data that do not support the EPA conclusions;
  - lack of supporting laboratory studies on ETS.

EPA: No Statutory Authority In The Workplace

The Occupational Safety and Health Administration (OSHA) has statutory authority for the workplace. OSHA presently is studying the issue of overall indoor air quality, including ETS. To date, OSHA has set no limitations on smoking in the workplace and does not impose liability on employers for injuries claimed to be related to ETS exposure. The EPA has no regulatory authority with respect to smoking in the workplace, and its report does not carry the weight of a regulation.

Although OSHA no doubt will take the EPA report into consideration, it is questionable how much weight it can be given. Aside from questions raised about the EPA report as previously noted, it is significant for OSHA's purpose, both legally and scientifically, that *EPA did not include workplace data* in its analysis. That data overwhelmingly fails to support claims of an increased health risk. In fact, nearly 90 percent of the available workplace studies report no statistically significant increase in overall lung cancer risk for non-smokers.

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OSHA is presently studying the issues of air quality in the workplace, and its rules should ultimately govern, given its statutory authority to regulate substances in the workplace. In the past, OSHA has rejected requests to restrict workplace smoking.

OSHA, realistically, has set permissible levels of workplace exposure for many substances, including those with Group A classification.

Therefore, despite the EPA report, the legal landscape for employers is essentially unchanged.

COURTS: NOT SUPPORTIVE OF ETS CLAIMS

Legally binding decisions on workplace-related ETS claims under any legal theory — Workers' Compensation, the Americans with Disabilities Act, Constitutional Law, and Common Law — historically have provided little support for workplace smoking bans. The EPA report provides no new research data that should modify this position.

In all such claims, the individual claimant bears the burden of proving both that:

Exposure to ETS (not something else) caused or substantially contributed to the claimed disease.	**AND**	*Exposure to ETS in the workplace (not other places) was the proximate cause of the disease.*

WORKERS' COMPENSATION CLAIMS — BURDEN OF PROOF REMAINS WITH CLAIMANT

Claimants filing suit under workers' compensation in the wake of the EPA report are no more likely than before to make a successful case regarding injuries alleged to have been caused by ETS exposure in the workplace.

In fact, an employee filing a workers' compensation claim would face obstacles beyond the ordinary burden of proof because many states require a claimant to establish that an injury arose out of and in the normal course of employment.

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> "At best, the workplace smoke aggravated [claimant's] ordinary disease of life condition, and an aggravation is not compensable. We further find that the claimant's evidence . . . failed to establish a direct causal connection between the conditions under which her work is performed and asthmatic bronchitis."[2]

Generally this means that an injury must result from a hazard or condition that is part of the job, such as exposure to cotton dust in a textile mill. ETS does not meet that standard. In a recent court decision, it was determined that ETS is not unique to the workplace, but is found outside the workplace as well. Therefore, the claimed injury did not arise out of the normal course of employment.[3]

Workers' compensation claims decided since the issuance of the EPA's report by the Virginia Workers' Compensation Commission, the Texas Workers' Compensation Commission and the Pennsylvania Workers' Compensation Appeal Board have denied workers' compensation benefits based on workplace related ETS claims.[4]

THE AMERICANS WITH DISABILITIES ACT (ADA) — REASONABLE ACCOMMODATION

An official of the U.S. Equal Employment Opportunity Commission, which enforces the ADA, has recently stated:

> "The ADA does not require employers to have a smoke-free environment or prevent it. It does not interfere one way or the other."[5]

The purpose of the Americans with Disabilities Act of 1990 is to prohibit discrimination on the basis of disability with respect to

2 Bennett v. Commonwealth of Virginia, Department of Taxation, N. 158-42-51 (Virginia Workers' Compensation Commission) (decided March 29, 1993).

3 Palmer v. Del Webb's High Sierra, 838 P.2d 435-46 (Nev. 1992).

4 Bennett v. Commonwealth of Virginia, Department of Taxation, N. 158-42-51 (Virginia Workers' Compensation Commission) (decided March 29, 1993); Burnett v. Polk Center, 1993 WL 93274 (Pennsylvania Workers' Compensation Appeal Board) (decided March 19, 1993); Appellant v. Respondent 1993 WL 87792 (Texas Workers' Compensation Commission) (decided March 19, 1993).

5 National Law Journal, March 1, 1993, p. 12.

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employment, public services, public accommodations and telecommunications. Under the ADA, if an employer makes a "reasonable accommodation" for a non-smoker (which employers should be doing in any event), it has met its burden, even if that person could establish a hypersensitivity to tobacco smoke under this law.

A federal appeals court recently ruled on a parallel provision of the Rehabilitation Act of 1973, and stated that providing an individual with a totally smoke-free environment went beyond an employer's obligation to provide reasonable accommodation.[6]

CONSTITUTIONAL LAW — NO "RIGHT" TO SMOKE-FREE ENVIRONMENT

Cases have been filed in the past alleging a fundamental, constitutional right to a smoke-free environment. Courts have rejected these claims, including constitutional challenges to smoking in public places such as the workplace.

> "[For a court to find a constitutional right to be free of tobacco smoke] would be to mock the lofty purposes of such amendments and broaden their penumbra protections to unheard-of boundaries . . . the inevitable results would be that type of tyranny from which our founding fathers sought to protect the people by adopting the first ten amendments to the Constitution."[7]

The case law is clear — there is no constitutional support for a non-smoker to dictate workplace smoking policy. The EPA report is unlikely to impact existing precedent.

COMMON LAW — NO "RIGHT" TO A SMOKE-FREE ENVIRONMENT

Claimants seeking to use common law to force smoking restrictions in the workplace also have met with little success. The

6 Pletten v. Merit Systems Protection Board, Nos. 88-1467, 89-1086 (6th Cir. 1990) (unpublished disposition), cert. denied 111 S. Ct. 768 (1991).

7 Gasper v. Louisiana Stadium and Exposition District, 418 F. Supp. 716 (E.D. La. 1976), aff'd, 577 F.2d 897 (5th Cir. 1978), cert. denied, 439 U.S. 1073 (1979).

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thrust of the court rulings in the majority of common law cases has been that an employer's duty extends only to providing a workplace that is reasonably safe for the normal employee.

> "[T]he common law does not impose upon an employer the duty or burden to conform his workplace to the particular needs or sensitivities of an individual employee. Without such a duty, appellant can complain of no wrong."[8]

An employee alleging a hypersensitivity to ETS is not owed a common law duty to a smoke-free environment under established case law.

The EPA report, once again, is unlikely to impact existing legal precedent.

SMOKING BANS WILL NOT ELIMINATE IAQ PROBLEMS

A common misconception is that tobacco smoke is the cause of poor indoor air quality (IAQ). In fact, visible accumulation of tobacco smoke usually is evidence of a more pervasive problem — inadequate ventilation. This point has been driven home by a number of recently publicized problems in schools, courthouses, workplaces, and even one of the EPA's own buildings — none of which allowed smoking.

Employees and others in these buildings were taken ill — some seriously — after being exposed to fumes and by-products of new construction and remodeling, and to fungus, viruses and molds that accumulated due to poor maintenance of ventilation systems. Owners and employers in several of these instances — the EPA included — have found themselves on the receiving end of lawsuits. The suit by employees of the EPA alleges health problems due to poor indoor air quality.

OSHA estimates that there are between 800,000 and 1.2 million "sick buildings" in the United States. Yet, studies of hundreds of buildings reveal that the vast majority of complaints are related to

8. Gordon v. Raven Systems & Research, Inc., 462 A.2d 10 (D.C. App. 1983).

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insufficient ventilation, inadequate filtration and poor maintenance, not tobacco smoke. Indeed, only 2% - 4% of complaints actually have been related to ETS. If the ventilation system is inadequate in handling moderate smoking levels so that smoke accumulates, it would also be inadequate to handle the buildup of other indoor air constituents.

Guidelines as to how to achieve acceptable indoor air quality in a broad range of environments, including non-industrial workplaces, with varied activity levels and a moderate amount of smoking have been provided by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

ASHRAE Standard 62-1989 *Ventilation for Acceptable Indoor Air Quality* specifies "minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to avoid adverse health effects."

These statistics point up the need for building owners and employers to take a broad-based approach to indoor air quality, regardless of their individual smoking policy.

Accommodating Smoking Is An Employer's Choice

We recognize the complexity of issues relating to a comprehensive consideration of indoor air quality. We also recognize the concerns of some individuals and organizations regarding ETS in the workplace. We are aware that some people may find smoking objectionable while others wish to smoke. We believe both can be accommodated. We acknowledge the choices of all employees, and encourage the accommodation of both smokers and non-smokers through tolerance, common sense, and courtesy. Unless otherwise regulated, employers can choose to accommodate smoking.

The preceding is taken from a presentation by D.F. Keane, Associate General Counsel, Philip Morris Management Corp. to the Virginia Manufacturers Association *Employment and the Law Seminar*, May 11, 1993.

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Best's Underwriting Newsletter

Joseph F. Mangan, CPCU, Editor

Volume 22, Number 2, February 1993

Will Passive Smoking Claims Burn Your Bottom Line?

The hazards of tobacco smoke are in the news again, but with a new twist that should make underwriters sit up and take notice. As we have previously reported (September, 1988 and July, 1992), cigarette manufacturers have been remarkably successful in defending product liability claims by smokers. In the wake of the U. S. Supreme Court decision we reviewed last July, the family of Rose Cipollone has abandoned the suit she initiated against three tobacco companies. More significantly, their attorneys, widely regarded as the most knowledgeable and successful plaintiff's counsel in tobacco product liability litigation, have moved to dismiss or asked permission to withdraw from each of the remaining actions in which they represent smokers against cigarette manufacturers. The tobacco industry's success has continued in Illinois, where a St. Clair County jury last month rejected Charles H. Kueper's claim of a tobacco industry conspiracy to deceive the public on the health hazards of smoking and ruled that the plaintiff, not R. J. Reynolds Co., bears responsibility for his lung cancer.

Recently antismoking activists have taken a new approach by seeking damages on behalf of nonsmokers whom they allege have been injured by other people's cigarettes. The first of these suits has not yet come to trial. When it does, we'll learn whether juries are more sympathetic to nonsmokers than they have been to smokers, whom they appear to regard as having voluntarily assumed the risks inherent in using tobacco products. In the meantime, it is these alleged nonsmoker injuries which the newest development addresses.

On January 7, the U.S. Environmental Protection Agency (EPA) released a report identifying environmental tobacco smoke (ETS) as a "Group A" (or known) human carcinogen and attributing the deaths of 3,000 adult nonsmokers annually to lung cancer induced by secondhand smoke. In addition to its primary finding, EPA also estimates that each year exposure to ETS, or "passive smoking," causes as many as 300,000 lower respiratory tract infections (e.g., bronchitis and pneumonia) among children under 18 months of age, and increases the frequency of episodes and the severity of symptoms in up to 1,000,000 asthmatic children. The report goes on to identify secondhand smoke as a causal factor in middle ear infections, associated upper respiratory tract infections, and reduced lung function in infants, and as a risk factor for the development of new cases of childhood asthma.

On January 7, the U.S. Environmental Protection Agency released a report identifying environmental tobacco smoke as a "Group A" (or known) human carcinogen.

The report's findings are likely to promote new state laws restricting smoking in public places, and they may prompt OSHA, which had deferred action on all indoor air quality issues pending the EPA study, to develop a new standard on smoking in the workplace. Experts also expect EPA's evaluation to provide additional ammunition to nonsmoking plaintiffs who claim to suffer from lung cancer induced by exposure to ETS. Plaintiff's attorneys specializing in tobacco products liability have already indicated that they anticipate expanding their litigation beyond tobacco manufacturers to employers and businesses that permit smoking on their premises. Such lawsuits, if they materialize, will certainly increase defense costs borne by general liability and workers compensation insurers, but they are far less likely to produce substantive damage awards.

Like most EPA reports, *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders* (December, 1992; United States Environmental Protection Agency) presents no new data. Rather, it is a

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weight-of-evidence study which bases its conclusions on a review of previously published research. The report draws its primary conclusions from 30 epidemiologic studies of the incidence of lung cancer among women from eight different countries who have never smoked but whose husbands have. All 30 studies used spousal smoking as a surrogate for exposure to secondhand smoke. Although each study observed a higher incidence of lung cancer among exposed women, only six originally found statistically significant differences, and none of the 11 United States studies reported a statistically significant increase in risk. Slightly more than half the studies (17) provide sufficient data for ranking subjects by exposure level. This ranking is critical to determining the existence of a dose-response relationship, an essential element in attributing causality. All 17 reports that ranked subjects found higher incidence of lung cancer among exposed subjects, and a majority of them (nine) report a statistically significant difference at the highest exposure level. Only one of the adult studies attempted to measure actual exposure to ETS, and none investigated its possible effects on male subjects.

In analyzing the data from previous studies, EPA staff and the Science Advisory Board had to contend with several circumstances which tend to impede the ability of scientific research to identify a statistically significant relationship between ETS and lung cancer. Detection of carcinogenic responses usually demands high exposure levels typical only of occupational settings and experimental animals who receive very high doses. Spousal smoking fails to produce the high level of exposure which researchers would prefer, and animal studies have measured exclusively the effects of mainstream smoke, which active smokers inhale.

The prevalence of secondhand smoke also tends to mask its true effects in two ways. Because virtually everyone is exposed to a measurable level of ETS, it is impossible to isolate a truly unexposed group for comparison to exposed subjects. Researchers must, therefore, employ the less powerful technique of comparing groups with different exposure levels. The background exposure also tends to obscure the effects of passive smoking in the experimental group, especially in the United States, where background exposure is generally higher than spousal exposure.

Because lung cancer is rare among nonsmokers, previous research has also suffered from low statistical power, which measures its ability to detect a real effect if that effect exists. Science can do little about the problems associated with low incremental exposure and significant background exposure, but it can improve statistical power when multiple studies are available. To accomplish this, EPA first adjusted all results downward to allow for misclassification of active and former smokers as never having smoked. They then assessed individual results for strength of association in both the overall results and the highest exposure group where exposure level data was available, as well as for exposure-response trend. Although two-thirds of the research originally reported no statistically significant association, the probability that the consistent results they report occurs by chance is infinitesimal (less than 10^{-4} or one in 10,000 for overall results).

As you might expect, tobacco manufacturers were quick to attack EPA, their report, its conclusions and the classification of ETS as a "Group A" carcinogen.

EPA then pooled the results, both positive and nonpositive, using accepted statistical techniques for combining data from different studies, to produce a larger database which enjoys significantly greater statistical power than any of the underlying studies. Applying a 90% confidence interval, EPA found a statistically significant increase in the incidence of lung cancer among all exposed subjects. Their results are consistent across studies and across diverse geographical areas, including the United States, Greece, Hong Kong, Japan, China and Western Europe.

Criticisms of the Report

As you might expect, tobacco manufacturers were quick to attack EPA, the report, its conclusions and the classification of ETS as a "Group A" carcinogen. In separate press releases on January 6 and 7, the Tobacco Institute, the industry's lobbying and public relations organ, accused EPA of "adjusting" science to fit a specific policy goal; discarding generally accepted statistical guidelines and ignoring significant new research in its evaluation of ETS carcinogenicity; basing its "Group A" classification of ETS on its chemical similarity to mainstream smoke; ignoring the recommendations of an expert panel EPA convened to evaluate it's own use of scientific evidence; and acting on the report's conclusions before they had been compiled. Because many people believe that the Institute has strained its credibility beyond acceptable limits, you might be tempted to dismiss their criticism as nothing more than industry propaganda. Some of their criticism, however, stands on a firm foundation and may influence judicial evaluation of future expert testimony based on EPA's findings. Reaction from groups who find the

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report's conclusions favorable to their positions has been much more restrained. In declining an interview, the Tobacco Products Liability Project, the leading antismoking activists, referred us to their published statements which address not the EPA report or its findings, but the effect of litigation on behavior and policies.

The strongest criticism of EPA's findings lies in their acceptance of statistical significance at a 90% confidence interval. This constitutes a significant departure from all past EPA hazard assessments as well as generally accepted research standards, which demand at least 95% confidence to support conclusions as strong as those EPA has drawn. Adoption of such a significant procedural change on a highly controversial issue may raise serious questions about the validity of their conclusions. As the Institute contends, EPA does in fact compare ETS to mainstream smoke, and states that their chemical similarity is sufficient to classify secondhand smoke as a "Group A" carcinogen when coupled with mainstream smoke's proven dose-related carcinogenicity and evidence of ETS uptake in nonsmokers. EPA uses this similarity, however, only to establish biological plausibility. It does not, as the tobacco industry would have us believe, form basis for their risk assessment or, by any stretch of the imagination, justify a comparable evaluation of, say, peanut butter. The Institute's insistence on evaluating only the results of individual studies also appears to be misplaced and would discard a valuable and scientifically valid tool for assessing data from diverse sources.

The Tobacco Institute further criticizes EPA for omitting significant new research, especially a study funded by the National Cancer Institute and published in November that found no statistically significant association between secondhand smoke and adverse health effects. Adding these findings to the database, they allege, causes the statistical significance of the link between passive smoking and lung cancer to disappear. Their position that EPA should withhold its findings while any new study is in progress is hardly feasible because it would permit any special interest group to forestall an unfavorable hazard evaluation simply by bankrolling new research. The National Cancer Institute research first appeared in November, while EPA was putting the finishing touches on their report, and requiring its incorporation into the database is unreasonable. Any new scientific evaluation supporting the Institute's contention, on the other hand, would serve to discredit the EPA's conclusions and impair their evidentiary value significantly.

Plaintiffs must still bear the burden of proving a causal relationship between exposure to secondhand smoke and their own injuries, a process which is significantly more difficult than simply attributing the deaths of 3,000 nonsmokers each year to passive smoking.

It is also true that EPA awarded a contract for preparation of a "Workplace Policy Guide" on smoking before finalizing its formal risk assessment, but this is not necessarily indicative of bias or subordinating science to predetermined policy objectives. Because research begins with gathering, collating and analyzing data, its conclusions are often known before drafting of the formal report begins. This process takes months, sometimes years for government agencies, and it is difficult to accept the argument that the public interest demands dotting the "i"s and crossing the "t"s before taking action.

Pronouncements of the plaintiff's bar notwithstanding, there is little reason to anticipate any significant impact on damages underwriters can expect to pay nonsmoking victims of lung cancer or other respiratory ailments as a result of EPA's classification of ETS as a "Group A" carcinogen. Plaintiffs must still bear the burden of proving a causal relationship between exposure to secondhand smoke and their own injuries, a process which is significantly more difficult than simply attributing the deaths of 3,000 nonsmokers each year to passive smoking. The scientific evidence supporting the risk assessment is the least persuasive EPA has ever accepted, and there are already indications that new research may discredit their findings. Epidemiologic research, which is the foundation of almost every hazard evaluation, is also of little value in assigning the likely cause of any individual case of lung cancer. In addition, tobacco companies remain the most promising defendants, and they have long since abandoned the search for affordable product liability insurance.

The judiciary may also take evidence of the adverse health effects of secondhand smoke with a grain of salt. Burned by hundreds of lawsuits and several multimillion dollar verdicts founded on "scientific" evidence which was later discredited, judges have begun to take a critical look at expert testimony. A growing number of courts, including the notoriously liberal Ninth U. S. Circuit in California, have refused to admit expert testimony which is not based on generally accepted scientific theory and methodology. In departing from their own established standards and

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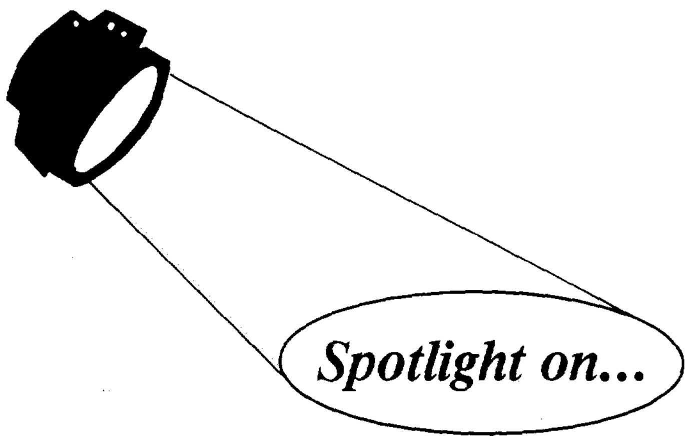
those of the scientific community, EPA may have brought their classification of ETS as a "Group A" carcinogen within the realm of questionable expert testimony which courts may exclude entirely or instruct jurors to scrutinize carefully. The scope of a judge's discretion to exclude expert testimony which fails to meet these criteria is now before the Supreme Court. We expect them to rule this Spring, and plan to report on this issue later this year.

Businesses that permit smoking on their premises may arguably face an exposure to claims by customers or employees, but the prevalence of ETS, the relatively low level of exposure and the lack of any scientific evidence linking it to adverse health effects should serve to insulate them. Plaintiffs who successfully overcome the burden of attributing their cancer to passive smoking will face the additional and formidable task of persuading a jury that a single source of exposure is at least the principal cause of their ill health. It is not difficult to conclude from reading EPA's report that exposure to ETS in social and occupational settings is pervasive, but that the only single source which makes a material contribution to the incidence of lung cancer is spousal smoking. Nicotine levels actually measured in public facilities that permit smoking also tend to be low, ranging from two to 20 micrograms per cubic meter. One hundred hours of breathing this atmosphere may yield less exposure to the harmful elements which tobacco smoke contains than actively smoking a single cigarette. The uptake of tobacco smoke products in this scenario is far below the threshold at which active smokers incur increased risk of lung cancer. It is also true that studies link only spousal and parental smoking to adverse health effects, and then exclusively in women and children. Research on occupational exposure to ETS and male subjects has consistently failed to find a statistically significant link to lung cancer or any other pathological condition.



...Bad News, Good News

As if their job wasn't tough enough, fire fighters now face a new occupational hazard: professional liability claims. Judges across the country have begun to allow suits charging that fire services failed to follow proper procedures in battling a blaze. Courts use the department's own manuals and the procedures of other fire services to establish the standard of care. While their tactics may provide grounds for a claim, however, courts have rejected every suit challenging fire service strategy: deployment of equipment and assignment of personnel and apparatus to individual fires.

In what has been reported as the first award of damages against a fire department for negligent failure to suppress a fire, the Supreme Judicial Court of Massachusetts affirmed a judgment against the City of Lowell. The jury awarded $850,000 in damages after determining that fire fighters caused the loss of five warehouses by diverting water from the buildings' automatic sprinkler systems to their own hoses, and the court reduced that to the $100,000 cap on municipal liability in Massachusetts. A federal court in New Orleans also found negligence but awarded no damages in a suit charging that fire fighters improperly cut off electricity to a burning building, disabling electrically powered sprinkler pumps.

The news isn't all bad, though. The spectre of professional liability claims should encourage fire services to improve their standard procedures and training, and the true beneficiary in these suits is often the fire insurer subrogated to the insured's right of action. Moreover, it's hard to object to judgments against anyone who turns off automatic sprinklers or diverts their water supply during a fire. *Best's Underwriting Newsletter* has always advocated sprinklers for both property protection and life safety applications, and the events we reported in September, 1992 clearly indicate their ability to work flawlessly, unless some idiot turns them off.

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Doctors, lawyers and building-associated diseases

The differing viewpoints of doctors and lawyers pose problems regarding causality in building-associated diseases

By Michael J. Hodgson, M.D., and Catherine A. Hess
Member ASHRAE

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Emerging legal concerns in indoor air quality

By Susan L. Rose, Ph.D.

Use of the courts to resolve environmental and social issues is a growing trend that must be considered when planning, designing, operating and maintaining indoor spaces. While this legal area is relatively new and liability too often unclear, it is now necessary at the outset for all participants in the process of building design, construction, operation and maintenance to address and minimize the potential for any future legal actions.

The following article is the first of a series that will explore some of these concerns, illustrate recent legal cases, discuss government indoor air quality (IAQ) activities, and outline some solutions for those with a financial and professional interest in IAQ.

These articles resulted from a series of seminars and forums on this topic that began in 1989 at the ASHRAE Winter Meeting in Atlanta. The articles in this series are intended to be informative and provocative, and to encourage IAQ concern as a priority among design professionals. ■

About the author

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Doctors, lawyers and building-associated diseases

The differing viewpoints of doctors and lawyers pose problems regarding causality in building-associated diseases

By Michael J. Hodgson, M.D., and Catherine A. Hess
Member ASHRAE

Buildings have traditionally been considered safe places to work. Still engineers are quite familiar with the engineering liability for building performance. Over the last several years, the threat of liability has also arisen for disease, raising compensation issues for owners, operators and tenants of these buildings. Increasing numbers of complaints have been voiced by occupants.

Although the cause of the "sick building syndrome" was initially considered to be solely decreased ventilation (either because of increased envelope tightness or decreased provision of outdoor air), this is no longer widely considered to be the case. The two primary causes of discomfort appear to be either relatively low levels of volatile organic compounds (VOCs) or microbial agents (spores, molds and fungi). Inadequate ventilation, poor operations and maintenance, and indoor sources of pollutants lead to exposures that generate potential health effects.

Building occupants' complaints may range in subjective severity from trivial to disabling. The decision on severity and medical validity of complaints (impairment) lies in the domain of doctors and scientists. On the other hand, compensation and disability are determined by lawyers, referees and the courts. Legal liability for disease may be ultimately imposed upon the owners, operators or tenants of many of these buildings through third-party lawsuits, raising compensation issues.

Conflicts exist between legal and medical definitions of causal relationships. Accordingly, this article discusses causation issues in the biomedical sciences, along with the criteria for assessing causality. These criteria have developed from review of epidemiological data and from clinical cases.

Legal definitions of causation are then summarized, and several classic approaches to causation in law and medicine are described and contrasted. Finally, several published cases of diseases related to buildings are detailed. Analysis of specific cases will

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help readers understand the process that occurs from the time of initial complaints to an ultimate opinion regarding the work-relatedness of disease.

A medical approach to illness

As people grow older, they develop increasing numbers of complaints with increasing frequencies. Within any two-week period, between 10% to 50% of the population at large will have complaints consistent with some "disease."

Obviously, most individuals do not visit a physician. Mechanic suggested that prospective patients present their complaints to colleagues, at some point hear that these complaints are unusual, and then decide to seek medical help.[1] Therefore, feedback from others may be more instrumental in driving individuals to become patients than the intensity of symptoms or subjective "disease." These others may include family and friends but, more recently, may also include media descriptions of illness.

At some point, patients come to accept that they may have a disease that requires medical intervention. The more credible the reinforcing source (friends, family, media or health practitioners) and the greater the respect the prospective patient has for the reinforcer, the more likely that individual will become a patient. However, the patients' understanding and experiencing of illness are separate from the physicians' understanding of disease and their own beliefs.

In the traditional model of disease and doctor/patient interactions, the patient's responsibility is to get well while the physician's responsibilities are to determine and explain the likely long-term outcome, and treat and heal the patient. Patients visit their physicians with complaints. Physicians attempt to classify the symptoms to some syndrome, allowing them to identify a likely mechanism of disease for which an appropriate test exists. Testing this mechanism allows physicians to determine the presence or absence of the disease in question.

About 60% to 75% of diagnoses can be made on the basis of symptoms alone. Some additional percentage (about 15%) depends on recognizing specific findings during physical examination. Another 5% to 10% require specific laboratory testing. In the remainder, no diagnosis is ever actually established. Therefore, diagnostic tests are not as useful or as necessary as the public generally assumes.

A second misconception is that physicians usually change the natural course of disease. This is often not true. In fact, the primary function of physicians is to support patients, often by precribing medication to make the disease tolerable.

Physicians often do not need diagnostic tests because they easily recognize the disease. For example, upper respiratory tract infections (leading to 500,000 lost workdays per year in America) can be diagnosed without any laboratory tests. Attempts to grow viruses in the laboratory or perform blood tests may be undertaken, but these will usually be considered inappropriate expenses and may not be reimbursed.

On the other hand, when new syndromes emerge or when physicians are confronted with patterns they do not recognize as clearly, they rely much more strongly on tests, even if the scientific accuracy of these tests is less than 100%. Nevertheless, a test may be helpful when applied in a specific situation where there is a reasonable prior probability of a disease being present. The degree of uncertainty that physicians are willing to tolerate results from considering the severity of the disease, the hazard and cost of the diagnostic tests, the costs of the disease, and the consequences of failing to make a different diagnosis.

The certainty with which physicians insist on making diagnoses is defined in medical terms, with medical consequences. For example, when a 50-year-old smoker has severe chest pain, it is often considered appropriate to hospitalize that individual. On the other hand, if a 20-year-old has similar complaints, hospitalization occurs less often.

The seriousness of the intervention, the potential consequences of failure to intervene, and the hazards to which physicians are willing to subject the patient depend on the hazard of the disease and the danger of treatment. The degree of certainty with which physicians pursue a precise diagnosis is in direct relation to the severity of the disease and the danger of the treatment (including changing jobs or residences, with major financial consequences).

Diseases are recognized with greater difficulty when they occur rarely, when the physician has not previously seen similar cases, or when the disease has not been described in the new context in which it is seen. That is, when a prior suspicion (probability) of disease is low, tests may be less useful. For example, a test may not be considered because a disease is thought to be unlikely in a specific situation.

Second, even if a disease is considered and a test ordered, the result may be disregarded. This is because the prior probability is low and the predictive value of the test for the presence of disease is lower than in a high probability situation.

In addition, tests may be falsely negative for several reasons. All tests can be characterized by their receiver-operating characteristic curves, which define the false positive and false negative results. Second, a specific patient may have a disease still in an early stage, so the abnormality measured by that specific test is not yet present.

Finally, getting well depends on additional factors not previously mentioned. In the work setting, several specific risk factors have been identified both for delayed recovery and for early (including too-early) return to work. Job satisfaction, lack of income support, individual culpability and adequate social support are clear predictors of rapid recovery. On the other hand, involvement in unforeseen (though preventable) accidents caused by others tends to lead to delayed recovery. These may be subsumed under the term "illness behavior."

Work-relatedness and causation of disease

Work-related disease. Traditionally, four levels of work-related disease have been defined: unambiguously work-related disease; disease that may be from work or from some other cause; disease to which occupational exposures may have contributed; and pre-existing disease exacerbated by work.

First, some diseases can, by their very nature, be caused only by one specific exposure. These diseases include the dust-induced lung diseases such as silicosis, which does not result from any other cause except prior silica exposure. Work in buildings has never been found to be the sole cause of diseases in this category.

Second, some diseases may be caused either by exposures at work or at home, but they clearly have more than a single cause and they may occur in a variety of settings. For example, asthma is a disease of airways' "twitchiness" after exposure to airborne chemicals or microorganisms. It may exist in an office worker and result from some specific exposure in the office or from a similar specific exposure at home.

Because asthma attacks do not necessarily resolve quickly, symptoms may persist well into the next day, week or even month. Asthma may be due to a specific microorganism that is found both at work and at home. Symptoms may actually occur in both

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places through the same mechanism and each may contribute to disease persistence.

Third, some diseases may exist before the individual enters the workplace and be exacerbated by current exposures. For example, individuals with pre-existing carpal tunnel syndrome might not experience the resulting hand/wrist/elbow pain at work until they are reassigned to a poorly designed workstation.

As another example, asthmatics are more sensitive to low levels of irritant chemicals. Thus, they may have increased symptoms at work without meeting the criteria for a diagnosis of true occupational asthma. Or individuals may have a disease to which more than one factor contributes. Smoking and asbestos exposure for lung cancer is one such example.

Fourth, some intervening illness (unrelated to the work at hand) may require individuals to change the precise nature of their employment. For example, loss of sight through a car accident may make it impossible for a clerk-typist to continue working in a prior job. When disease is considered related to work or affects work performance, the degree of the relatedness must be defined.

In diseases commonly attributed to buildings, specific criteria for work-relatedness may be defined. The list of illnesses with recognizable criteria and definable causes has been presented and discussed in Hodgson.[2] The remainder of this article defines the several techniques used to establish causal relationships in medicine.

Documenting causation. Because physicians have frequently failed to recognize occupational disease when it occurred, the body of knowledge of exposure-effect relationships is substantially lower than even many physicians expect. For example, Disher documented that, in work-related disease, the general diagnosis is actually correctly made, but up to 95% of the true causes are not recognized by the treating physicians as being occupational in origin.[3] Fifteen years later, physicians are still not much better at identifying work-related disease.

Overall, physicians consider three levels of scientific evidence to link a disease with exposures: epidemiology, toxicology and clinical trials.[4] Epidemiology (the study of where and why diseases occur; or the distribution and determinants of disease) is the evidence collected in the practice of medicine and the investigation of large groups of individuals.

Toxicology (the science of poisons) allows the identification of harmful effects of certain substances under controlled conditions. Finally, the practice of clinical medicine, with individual patients, has defined a scientific technique (the n-of-one clinical trial) to link specific effects with specific causes.

In the 1950s, Bradford-Hill and Doll first summarized the criteria now generally used as epidemiologic criteria for causation.[5] This approach is used when large-scale studies of humans have been undertaken, when appropriate measurements of exposure have been obtained, and when several cohorts are available for review.

The criteria themselves include strength (magnitude of the effect), consistency (present in multiple studies or groups), temporality (cause precedes the effect), dose-response relationships (the more exposure, the greater the effect), specificity (few other causes of the effect), and plausibility (a likely mechanism).

Many exceptions can be found for each of these criteria. It is rare for even three or four of them to be seen in one set of studies on a specific topic. In addition, this approach assumes that multiple epidemiologic studies have been performed, which is often not the case. Nevertheless, where epidemiologic criteria are available, they have generally been considered reasonably convincing.

Toxicology (the scientific study of poisons) generally uses living animals, bacteria and fungi, or isolated portions of cells (such as specific proteins), exposes them to controlled amounts of poisons, and measures effects. Fundamental aspects of toxicology include:

- The concept of the critical organ (a specific portion of the body is always affected first);
- Structure-activity relationships (the effect of an agent is substantially predictable on the basis of its molecular structure); and
- Controlled exposure to define a delivered dose (application of the poison in the route that it is toxic—inhaled, eaten, absorbed through the skin, etc.—in amounts likely to be associated with toxic effects, alone or in combination).

For many agents of interest in indoor environments, the mechanisms, necessary doses and the interactions of agents have not been defined.

Where large-scale epidemiologic studies have not been performed, specific agents are uncertain and controlled laboratory experiments are not possible, on-site evaluation of effects may be attempted. A general description of this approach is available in the medical literature.[6,7]

The measurement most likely associated with the health effect of interest is obtained repeatedly, under varying exposure conditions (i.e, at work and at home). Differences can then be identified or patients assured that the most likely adverse health effect is not measurable.

As an example, one can consider whether hypersensitivity pneumonitis (HP) can result from exposure to one of several ventilation systems in a specific building. A case of disease must be established, using standard clinical criteria for diagnosis. Epidemiologic criteria for a causal relationship would be found according the list above, but the cost of such a study (thousands of dollars per patient evaluation), the size of the available population in the building (usually less than 2% to 4% of building occupants have HP), or the lack of prior studies would make it difficult to use epidemiology.

A specific organism could be identified by using toxicologic studies (i.e, animal and bench laboratory models). On the other hand, no generally accepted animal model may exist for the causal agent. Toxicology may then provide no answer.

In the absence of epidemiology or toxicology, physicians must rely on other methods of diagnosing HP in the specific case. Traditional diagnostic tools such as chest x-rays, lung biopsy, pulmonary function studies and immunologic testing may provide much more rapid and reliable answers.

Modern philosophy of science. In general, experimental methods are superior to non-experimental methods in discovering and establishing the existence of causal relationships.[8] The initial postulates of Koch were developed for the documentation of an infectious etiology or cause for diseases. The postulates stated:

> *The agent or organism occurs in every case of disease in circumstances which can account for the pathological changes in its clinical course. It occurs in no other disease as a fortuitous, non-pathogenic agent. After being fully isolated and separated from the body and repeatedly brought in for culture, it can induce the disease anew.*

Nevertheless, the postulates themselves still serve, in modified form, as the basis for scientific proof.[9] Implicit in the postulates is a pure experimental setting.

These concepts were expanded by Evans[10] into a "unified concept of causation" that encompasses the following 10 points:

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- The prevalence of disease should be significantly higher in exposed than in unexposed individuals.
- Exposure to the putative cause should be more common in individuals with disease than without.
- Incidence of disease should be higher in individuals with disease than without, in perspective studies.
- Disease should follow exposure to the putative agent, with a distribution of incubation or latency periods.
- A spectrum of host responses should follow exposure to the putative agent, along a biological gradient from mild to severe.
- A measurable host response should occur after exposure or increase presence before exposure.
- Experimental reproduction of disease should occur in animals or man after exposure to a greater degree than in those not exposed.
- Elimination and modification of the putative cause should decrease incidence of disease.
- Prevention or modification of the host's response to the cause should decrease or eliminate the disease.
- The relationship should be biologically and epidemiologically plausible.

Where no specific agent has been implicated, many of these criteria may not be fulfilled. Therefore, although experimental design always provides a more certain scientific answer than studies without an experimental component, we are frequently left without possible recourse to the Koch postulates. Molhave has summarized the evidence that low levels of VOCs are at least one potential cause of the sick building syndrome.[11]

Legal definitions of causal associations

In contrast to medical approaches to disease, legal approaches in building-related illness are based on the question of whether a disease can be attributed to a specific exposure or a specific building, so that a "wrong" can be righted. The goal is not necessarily to return an employee to gainful employment, to prevent disease or illness, or to solve a problem.

When presenting the facts of a case to a judge or jury, a lawyer must rely on the opinions of professionals with expertise in certain relevant areas. The usual approach is to inquire whether a physician or other expert considers that a medical condition is caused by a specific setting. The definition of causal relationships and the likelihood or probability of causation in the expert's mind become critical issues.

With our current legal system, the burden of proof is usually met in these cases when the evidence can demonstrate a 51% probability of an association. In fact, physicians do not necessarily distinguish between 51% or 50% or 52% probabilities, and admit that distinctions on that level are quite arbitrary.

(Workers compensation statutes vary from state to state, and will not be dealt with in this article. Readers are referred to local sources, such as occupational physicians or lawyers, for any questions.)

However, in many of these cases, lawyers are attempting to bring a legal action for negligence. Negligence has been defined as conduct that falls below the standard established by law for the protection of others against unreasonable risk of harm.[12] Negligence does not require either reckless or intentional behavior. Negligent conduct may consist either of an act or an omission. The former involves an unreasonable risk of harm. The latter consists of a failure to act for the protection or assistance of another when there is a duty to do so.[13]

There are four required elements of a cause of action for negligence. First, the defendant must have a legal duty to conform to a specific standard of conduct, so that the plaintiff is protected against an unreasonable risk of injury. Second, the defendant breaches this duty if the behavior in question is not in conformance with the required standard.

Third, the defendant's breach of duty must constitute the actual and proximate (legal) cause of the plaintiff's injury. Briefly, proximate or legal cause occurs when there are no unforeseeable, intervening or superseding events to break the natural and continuous chain of events from defendant's behavior to plaintiff's injury. Causation is as difficult an area in law as it is in medicine. Finally, a negligence action requires that the plaintiff suffered actual, measurable harm to himself or his property.

Generally, the questions asked are can the physician state "with reasonable medical certainty" that a specific effect results from a specific cause (in workers' compensation) or whether the relationship is "more probable than not" (civil litigation). These are not medical terms, and physicians are hard pressed to understand and explain their thought processes.

From a medical perspective, the severity of the illness, the ease and danger of making a diagnosis, and the hazard of the diagnostic procedure all enter into that opinion. Therefore, even a 30% chance of a specific disease may lead physicians to act on a hypothesis without further diagnostic measures. In this case, they may be "reasonably medically certain" if the potential disease is severe, the treatment harmless and the diagnostic test dangerous.

On the other hand, for trivial complaints with even a 60% likelihood of a causal relationship to a workplace, physicians may be generally unwilling to stake their professional reputation and expertise on a possibility that is not important.

Some abnormalities are clearly related to an occupational exposure, with changes in some measurable health outcome that allows linkage to a specific source. The ability to link a physiologic abnormality is essential to documenting causal associations in a scientific sense. The legal context in which these associations must be proven varies: workers compensation proceedings, arbitration or jury trials.

The scientific facts may be presented as evidence. However, other, non-scientific aspects may also be presented and these may not be credible from a strictly scientific view.

Causal associations of building-related illness

Each of the models developed above has been applied to specific cases of disease that were reported in the scientific literature. This section addresses some of the diseases seen from occupational exposures in buildings. Specific cases are also presented to document how the various techniques may be used.

Sick building syndrome. Over the last 15 years, various symptoms (headaches, fatigue, dizziness and eye, nose and throat irritations) have been seen with varying frequencies in office workers. Traditionally, these symptoms have not been considered as part of a disabling disease. Nevertheless, some office workers have complained severely about an inability to work.

There is some evidence that these complaints are related to low levels of VOCs, both from experimental chamber studies[11] and from field studies.[14] A few large-scale studies have been published[15] and demonstrated that the symptoms are more frequent in buildings with mechanical ventilation. However, there are generally no good, readily available clinical markers to distinguish sick from non-sick individuals.

These neurotoxic symptoms are consistent with Molhave's definitions of the sick building syndrome and represent abnormalities that are interpretable as resulting from VOC exposures. There is evidence from large-scale epidemiologic studies that these

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symptoms occur excessively in office workers in buildings with mechanical ventilation systems. In this case, there is adequate evidence to justify an administrative action to reassign the individual to a different workplace.

Legionnaire's disease. Between 50,000 to 70,000 cases of Legionnaire's disease are thought to occur each year in America, with about 15% ending in a fatality. The disease generally presents as a pneumonia. Individuals who develop the disease generally have some impairment of their defenses such as occurs with aging, lung disease (asthma or pulmonary disease from cigarette smoking) or suppression of the immune system. (The immune system recognizes and destroys foreign substances.)

Two modes of disease transmission have been identified. First, patients may inhale droplet aerosols, such as occur in cooling tower plumes. Second, they may drink water contaminated with *Legionnella*. In this case, the bacteria may colonize the patient's throat and the saliva may get into the trachea (aspiration). In the presence of impaired lung defenses, the bacteria cannot be coughed out or otherwise cleared from the lungs, resulting in pneumonia.

Up to half of the bodies of water in America are believed to contain *Legionnella* strains. Risk factors for the colonization of water systems have been recognized. These include the presence of electric water heaters in upright tanks, scale development, blind pipe ends and kinking of pipes. The disease is not rare, with about 5% of all pneumonias attributed to *Legionnella.*

Criteria for the diagnosis of work-related Legionnaire's disease include:

- A recent illness consistent with Legionnaire's disease;
- Blood testing or culture evidence of a recent infection with *Legionnella* bacteria; and
- Evidence for the same organism present in the workplace, but ideally not at home.[16]

Serologic evidence consists of either a four-fold increase in antibody titers to *Legionnella* strains or a single titer measurable in a dilution of greater than 1:256. (Titer is the concentration of a substance in solution.)

If true outbreaks are seen with many cases occurring at the same time (as occurred with the original Legionnaire's disease outbreak), then it is considered legitimate to attribute a diagnosis to a specific source even if no route of transmission or specific source may be identified. Where single, sporadic cases are seen, the same organisms must be identified in the human body and in the water source, meeting the above criteria.

Similar considerations apply to other diseases with well-defined clinical markers. For example, cases of asthma or hypersensitivity pneumonitis have been described and attributed to work in buildings on numerous occasions.[17] In general, such cases were convincing because tests were performed that clearly linked changes in lung function to presence at work in the building in question but not elsewhere.

Using animal data. Medical tests are not available to diagnose all health effects and attribute them to building use. Where groups of workers are seen with specific complaints and likely causes are identified, it is sometimes unethical to re-expose the workers. However, animals may be exposed. When documented exposure reproduces changes in animals that correspond to human complaints, convincing evidence may also accrue.

Although animal studies cannot be extrapolated to humans without questioning, the science of experimental toxicology is based on the assumption that some effects are similar in man and animals. For example, carpet shampoo had an irritating effect leading to a specific respiratory response in rodents. Although no humans were exposed and although rodent respiratory tracts are somewhat different from those of humans, the presence of respiratory irritation in rodents is presumptive evidence of an adverse effect.[18]

New diseases. When diseases have not been seen in specific environments, disease-exposure relationships become more controversial. Consequently, more innovative approaches must be used to determine whether the effect in question is actually attributable to the putative cause.

If a specific disease is postulated, some defined bodily function can be identified that should change or become abnormal, if the disease is related to work. For example, pesticide poisoning is generally not thought to occur among office workers. However, outbreaks have been reported.[19]

Subsequent review of an EPA database revealed that hundreds of similar cases had been reported but never disseminated further.[20,21] In the presence of reports (albeit not published) and convincing biochemical evidence, this case was considered reasonably convincing.

As new syndromes are recognized or diseases associated with additional causes, similar descriptions linking them to the new inciting event will be published. These reports must be carefully scrutinized.

Conclusion

When physicians are faced with patient complaints, they may define a syndrome in pathophysiologic measures. They must then decide whether tests are necessary for a specific diagnosis and, at least as importantly, they must decide how good these tests are at determining the presence or absence of disease. If epidemiologic evidence is present, it may be inappropriate to perform tests only on an individual basis.

Depending on the degree of hazard, a new appropriate test may be developed. However, there must be some relationship between the degree of hazard in the test and the benefits of a diagnosis. In the absence of either demonstrated physiologic changes or epidemiologic studies that suggest the legitimacy of a certain symptom complex, it is difficult to make a convincing argument for action.

In an ideal setting, employees with a building-related illness may simply be reassigned to another environment. This could be even within the same building and even in the absence of rigorous documentation of the presence of a problem.

At times, employers fare better when reassigning employees to a more comfortable or healthy workplace because of the social and organizational dysfunction that may be induced by leaving a disgruntled, sick or unhappy employee in a specific setting. The economic trade-offs have been described in Woods.[22] ■

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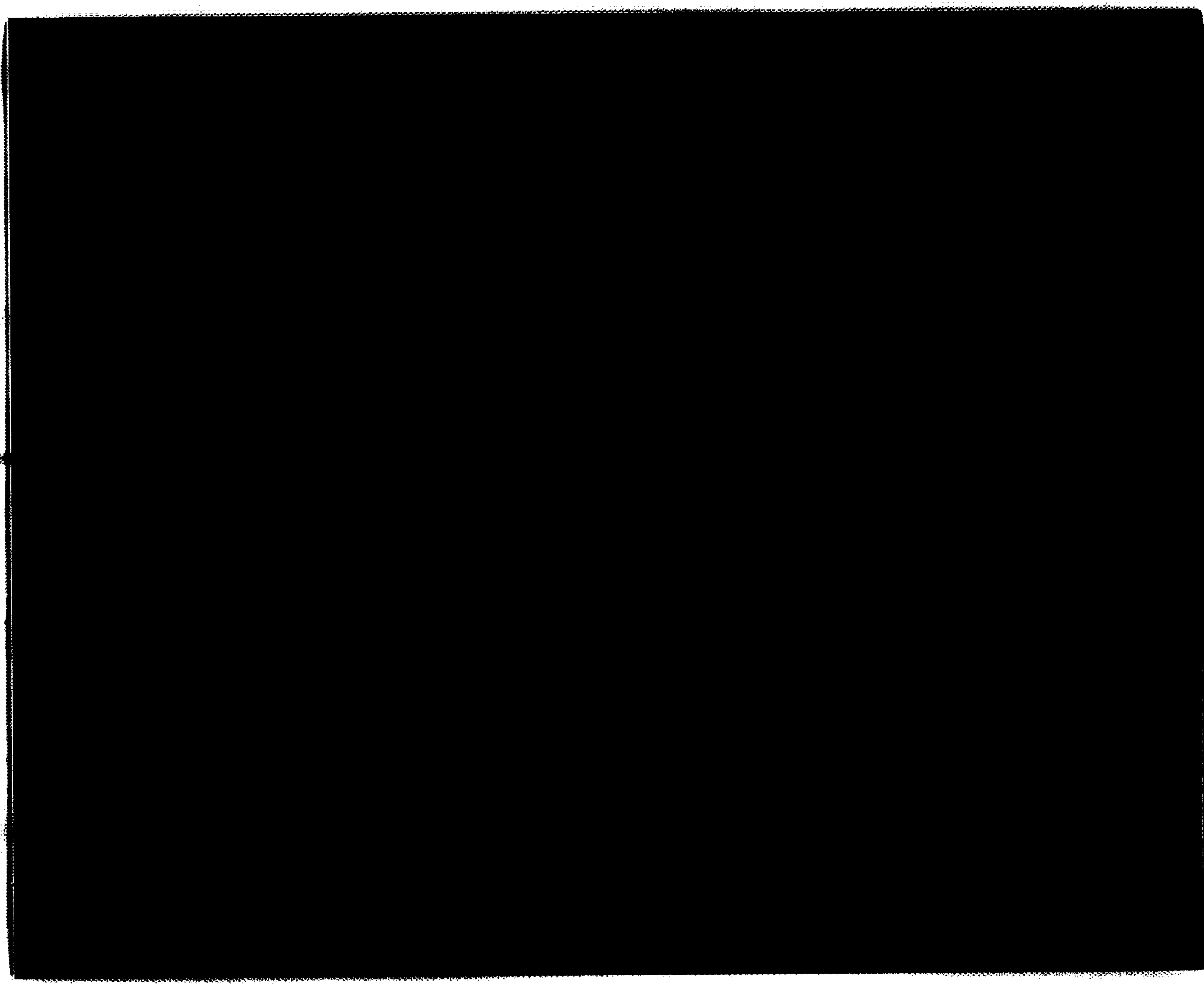

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